EXPLORING THE USE OF OPEN EDUCATIONAL RESOURCES IN CHEMISTRY LABORATORY COURSE CONTEXT: A CASE STUDY

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

SEÇİL TISOĞLU

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
COMPUTER EDUCATION AND INSTRUCTIONAL TECHNOLOGY

OCTOBER 2017

Approval of the thesis:

EXPLORING THE USE OF OPEN EDUCATIONAL RESOURCES IN CHEMISTRY LABORATORY COURSE CONTEXT: A CASE STUDY

submitted by **SEÇİL TISOĞLU** in partial fulfillment of the requirements for the degree of **Doctor of Philosophy in Computer Education and Instructional Technology Department, Middle East Technical University**, by

Prof. Dr. Gülbin Dural
Dean, Graduate School of **Natural and Applied Sciences** _____________

Prof. Dr. Soner Yıldırım
Head of Department, **Computer Education and Instructional Technology** ______

Prof. Dr. Kürşat Çağıltay
Supervisor, **Computer Edu. & Instruct. Tech. Dept, METU** _____________

Assoc. Prof. Dr. Engin Kurşun
Co-Supervisor, **Computer Edu. & Instruct. Tech. Dept., Atatürk University** ____

Examining Committee Members:

Prof. Dr. Mustafa Sözbilir
Mathematics and Science Education, Atatürk University _____________

Prof. Dr. Kürşat Çağıltay
Computer Edu. & Instruct. Tech., METU _____________

Prof. Dr. Soner Yıldırım
Computer Edu. & Instruct. Tech., METU _____________

Prof. Dr. Oya Yerin Güneri
Educational Sciences, METU _____________

Prof. Dr. Nurettin Şimşek
Computer Edu. & Instruct. Tech., Ankara University ______________

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last name : Seçil Tısoğlu

Signature :

ABSTRACT

EXPLORING THE USE OF OPEN EDUCATIONAL RESOURCES IN CHEMISTRY LABORATORY COURSE CONTEXT: A CASE STUDY

Tısoğlu, Seçil
Ph.D, Department of Computer Education and Instructional Technology
Supervisor : Prof. Dr. Kürşat Çağıltay
Co-Supervisor: Assoc. Prof. Dr. Engin Kurşun

October 2017, 397 pages

The first purpose of this study is to provide a detailed perspective for the use and integration of Open Educational Resources (OER) into chemistry laboratory courses through the students', faculty members' and teaching assistants' perspective. Specifically, the factors affected the use and integration of OERs into general laboratory course context through systemic perspective was explained in detailed. The second purpose of this study is to present the impact of these resources on users' perceived performances. The OERs, which were prepared for General Chemistry Laboratory course, are provided in video and virtual formats as an optional choice for the use through the laboratory course in METU OpenCourseWare (OCW) website. Through the purposes of this study, case study method was followed in line with the system theory as a theoretical perspective. The participants of this study were freshmen students who took General Chemistry course, and the faculty members and teaching assistants that were responsible for this course. The data was conducted through two semesters within different qualitative (from two responsible departments (Metallurgical and Materials Engineering & Mining Engineering) and quantitative (from the departments that are responsible for 111/112 course) data collection methods. The results of the study showed that personal, course (system) related, resources related and policy issues had major roles on the use and integration of the OERs into the formal education context. In addition, the creation of the OERs did not provide a path for the use of the resources, rather the system components, policy practices and users' behaviors, expectations and motives should be considered to provide sustainable usage and integration of the resources. In line with these inferences, when the OERs were used, the effects on the users' perceived performances displayed more satisfactory results on their affective and psychomotor experiences.

Keywords: OER, OCW, General Chemistry Laboratory Course, system theory

ÖZ

AÇIK EĞİTİM KAYNAKLARI KULLANIMININ KİMYA LABORATUVAR DERSİ BAĞLAMINDA İNCELENMESİ: BİR DURUM ÇALIŞMASI

Tısoğlu, Seçil
Doktora, Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü
Tez Yöneticisi : Prof. Dr. Kürşat Çağıltay
Ortak Tez Yöneticisi: Doç. Dr. Engin Kurşun

Ekim 2017, 397 sayfa

Bu çalışmanın ilk amacı, öğrenciler, öğretim elemanları ve asistanların bakış açısından Açık Eğitim Kaynaklarının kimya laboratuvar derslerinde kullanımı ve bu derslere entegre edilmesine yönelik ayrıntılı bir anlayış sunmaktır. Spesifik olarak, bu çalışmanın ilk amacı açık eğitim kaynaklarının kullanımı ve entegre edilmesine etki eden faktörleri sistemik bir perspektiften ayrıntılı bir şekilde açıklamaktır. Çalışmanın ikinci amacı ise, bu kaynakların, kullanıcıların algılanan performanslarına olan etkilerini ortaya koymaktır. Kimya laboratuvar dersleri için hazırlanan Açık Ders Kaynakları (materyalleri), video ve sanal ortam formatında isteğe bağlı kullanım seçeneğiyle ODTU OCW sayfasında sunulmaktadır. Bu amaçlar çerçevesinde, durum çalışması metodu, teorik altyapı olarak faydalanılan sistem teorisi ile uyumlu bir çerçevede kullanılmıştır. Katılımcılar, Genel Kimya dersini alan birinci sınıf öğrencileri, Kimya Bölümü öğretim üyeleri ve dersin asistanlarından oluşmaktadır. Veriler iki yarıyıl boyunca nitel (Metalürji ve Malzeme Mühendisliği ve Maden Mühendisliği) ve nicel veri (111/112 kodlu Genel Kimya dersinden sorumlu tüm bolümler) toplama yöntemleri kullanılarak toplanmıştır. Çalışmanın sonuçlarına göre, kişisel, dersle (sistemle) ilişkili, materyal ile ilişkili ve politik meseleler, Açık Eğitim Materyallerinin geleneksel eğitim ortamında kullanılması ve entegre edilmesinde önemli rollere sahiptir. Buna ek olarak, bu materyallerin yaratılması tek başına materyallerin kullanılmasında yeterli olmamaktadır, bunun yerine sistem (ders) bileşenleri, politika uygulamaları, kullanıcıların davranışları, beklentileri ve motivasyonları, daha sürdürülebilir bir kullanım ve entegrasyon için göz önünde bulundurulmalıdır. Bu sonuçlarla ilintili olarak, bu materyaller kullanıldığında, materyallerin kullanıcıların algılanan performanslarının duygusal ve psikomotor deneyimlerinde daha yeterli sonuçlar elde edildiğini göstermiştir.

Anahtar Kelimeler: Açık eğitim kaynakları, açık ders materyalleri, genel kimya laboratuvar dersi, sistem teorisi

To my beloved family

ACKNOWLEDGMENTS

First, I would like to express my deep gratitude to my supervisor Prof. Dr. Kürşat Çağıltay for his endless support, guidance, and encouragement through this study. He always gave his support for the research and other problems in my life. I was also lucky to have my co-supervisor Assoc. Prof. Dr. Engin Kurşun for his valuable encouragement, assistance and expertise for finishing this study as well.

I would like to express my special thanks to my thesis monitoring committee members Prof. Dr. Soner Yıldırım and Prof. Dr. Oya Yerin Güneri for their valuable comments and feedbacks throughout the study. I would also like to thank to my examining committee members Prof. Dr. Mustafa Sözbilir and Prof. Dr. Nurettin Şimşek for their critical and valuable suggestions, feedbacks and comments to improve this study.

I would like to thank the faculty members and research assistants in Chemistry Department for their support during the process. They helped me to conduct my study with their critical advices and feedbacks.

I would like to thank the Scientific and Technological Research Council of Turkey (TÜBİTAK) for the support of national scholarship and visiting scholarship during my PhD education. I am also grateful to State Planning Organization (DPT) and Middle East Technical University (METU) for the support of my study.

I would like to thank all my friends who gave unconditional support and encouragement, especially Ersin Kara, Mustafa Güleç and Mithat Çiçek. I want to thank Gülenay Vardarlı Korgan who made the process easier for me with her support. I would also like to thank my friend Sezin Eşfer Günay for her personal and academic support during the process. I am also grateful for my advisor Prof. Dr. Vanessa Dennen and my friends Jiyae Bong and Chen Sun from Florida State University for their encouragement and moral supports.

I am also grateful to my best friends Esra Kavasoğlu and Oya Kırcelli who always help me by their love and compassion throughout the process. I would like to thank my dearest friend Mehtap Kuş for her kindness, encouragement and insight who knows the process as well as I am. Also, I would like to thank to my beloved friends Eymen Canatan and Durmus Kuş for their encouragement and favors throughout the process.

I want to thank to my beloved family who always improves and encourages me with their endless love and faith. Particularly my parents Hülya Tısoğlu and Vedat Tısoğlu who always give their unconditional love through my life and my beloved sister Sinem Şimsek who always inspired me with her personality. My lovely and dearest niece Melis Şimsek who makes me love children and who make my life more beautiful with her presence. My brother in law Berat Şimşek who always give valuable advices for my personal and academic life. At least I would also like to thank my mother in law Hatice Kaya, father in law Ertuğrul Kaya and sister in law Pınar Kaya Keskin for their endless encouragement and support for my personal life and career. I would like to thank all the members of my beloved family; you will always be loved.

I would like to give my greatest gratitude to my great husband Kadir Yücel Kaya. His patience, love and support made this dissertation as it is. He always make my day great and livable and make me to believe myself for my career. He always encourages me through my personal and academic life. Thank you for all my love.

TABLE OF CONTENTS

ABSTRACT v
ÖZ… vii
ACKNOWLEDGMENTS x
TABLE OF CONTENTS xii
LIST OF TABLES xvi
LIST OF FIGURES xvii
LIST OF ABBREVIATIONS xviii
CHAPTERS
1. INTRODUCTION 1
1.1 Introduction 1
1.2 Background of the Study 2
1.2.1 Awareness and the Use of OER 2
1.2.2 Adoption of OER 4
1.2.3 Impact of OERs on Teaching and Learning Practices 6
1.3 System Theory as a Framework for this Study 8
1.4 Problem Statement 9
1.5 Purpose of the Study 9
1.6 Significance of the Study 10
1.7 Research Questions 12
1.8 Definition of Terms 13
2. REVIEW OF THE LITERATURE 15
2.1 Open Educational Resources 15
2.1.1 OpenCourseWare 18
2.1.2 OER Movement in Turkey 19
2.2 Use and Integration of OERs 20

2.2.1 Use of OER in Science Laboratory Context 25
2.3 Impact of OERs on Teaching and Learning Activities 31
2.4 System Theory as Research Framework 33
2.4.1 System-Environment Model 34
2.4.2 Function-Structure Model 35
2.4.3 Process Model 36
2.5 Implications of Literature Review 37
3. METHODOLOGY 39
3.1 Introduction 39
3.2 Research Questions 39
3.3 Methodology 40
3.3.1 Research Method 40
3.3.2 Case Study 40
3.4 Theoretical Orientation 50
3.4.1 Systems-Environment Model 51
3.4.2 Function-Structure Model 56
3.4.3 Process Model 64
3.5 Research Design 68
3.6 Research Participants 72
3.7 Data Collection 78
3.8 Data Analysis 85
3.8.1 Quantitative Analysis 85
3.8.2 Qualitative Analysis 85
3.8.3 Interview & Observation 86
3.8.4 Theoretical Orientations for Data Analysis 90
3.8.5 Documents 94
3.9 Quality of the Research Design 95
3.9.1 Prolonged engagement &Persistent observation 98
3.9.2 Triangulation 99

3.9.3 Negative cases 100
3.9.4 Peer review/Debriefing 100
3.9.5 Inter-rater Reliability 101
3.9.6 Member Checking/Respondent Validation 102
3.9.7 Thick Description 103
3.9.8 Ethical Issues 103
3.10 Researcher’s Role 104
3.11 Limitations 105
4. RESULTS 107
4.1 Use Theme 107
4.1.1 Preparations for the Course 108
4.1.2 Usage Profile 110
4.1.3 Reasons to Use the OERs 116
4.1.4 Reasons not to Use the OERs (Barriers) 123
4.2 Adoption-Implementation Theme 131
4.2.1 Teaching Process 131
4.2.2 Experimentation Process 137
4.2.3 Assessment Process 142
4.2.4 External Factors 147
4.2.5 Integration of the OERs into the System 148
4.3 Policy Theme 153
4.3.1 OER culture 153
4.3.2 Department Support 169
4.3.3 Desired Strategies-Practices 185
4.3.4 Institutional Practices 204
4.4 Performance-Outcomes Theme 210
4.4.1 Expectations about the Course (Input) 211
4.4.2 Academic Performance Outcomes 214
4.4.3 Cognitive Outcomes 220

4.4.4 Psychomotor Skills and Activities 229
4.4.5 Affective Outcomes 232
4.4.6 Satisfaction of the Learning Experience (Output) 262
4.5 Summary of the Results from System Theory Perspective 263
5. DISCUSSION AND CONCLUSION 271
5.1 MAJOR FINDINGS OF THE STUDY 271
5.2 DISCUSSION 274
5.2.1 RQ1. Which factors influence use and integration of OERs into chemistry laboratories? 274
5.2.2 RQ2. How do the utilization of resources facilitate the students and research assistants' perceived performances through the laboratory course? 298
5.3 CONCLUSION AND RECOMMENDATIONS 310
5.3.1 Recommendations for Institution 310
5.3.2 Recommendations for Department 315
5.3.3 Recommendations for Faculty members, Research Assistants, Teachers 318
REFERENCES 333
APPENDICES
A. TURKISH VERSION OF OCW QUESTIONNAIRE 353
B. INTERVIEW PROTOCOL FOR STUDENTS 357
C. INTERVIEW PROTOCOL FOR TEACHING ASSISTANTS 363
D. INTERVIEW PROTOCOL FOR FACULTY MEMBERS 369
E. OBSERVATION PROTOCOL 375
F. INFORMED CONSENT FORM 379
G. CODING SCHEME 381
H. IRB APPROVAL 393
CURRICULUM VITAE 394

LIST OF TABLES

TABLES

Table 2.1 Laboratory Instruction Styles 26
Table 3.1 Inputs and outputs of the system related with the OERs 55
Table 3.2 Image of the system 57
Table 3.3 Specifications of the system 60
Table 3.4 Functions and activities of the system provided 62
Table 3.5 Courses and responsible departments offered General Chemistry Laboratory Experiments through OCW 74
Table 3.6 Denomination across group of participants 75
Table 3.7 Data collection methods related with the system models 84
Table 3.8 Data collection and data analysis process 89
Table 3.9 Coding of outcomes from students group 90
Table 3.10 The revised taxonomy table (Krathwohl, 2002, p. 216) 92
Table 3.11 Example of data analysis based on taxonomy 93
Table 3.12 Strategies for threats of four tests 97
Table 4.1 Demographic information of questionnaire participants 111
Table 4.2 Awareness and usage profiles of questionnaire participants 112
Table 4.3 Frequency of using the OERs through departments 113
Table 4.4 Information channels for students to aware of the OERs 189
Table 4.5 Frequency of awareness by departments 190
Table 4.6 Frequency of information channels by departments 190
Table 4.7 Effects of the OERs on students' performance 211

LIST OF FIGURES

FIGURES

Figure 2.1. OERs in classroom as a mainstream.. 22
Figure 3.1 Picture from the classroom setting 45
Figure 3.2 Picture from the classroom setting 45
Figure 3.3 A screenshot of recorded chemistry laboratory experiments 48
Figure 3.4 A screenshot of interactive virtual laboratory experiment 50
Figure 3.5 Embeddedness of the system.. 53
Figure 3.6 Components and process of the system.. 65
Figure 3.7 Processes of the system through the system environment........................ 67
Figure 3.8 Design of the case study for the first & second semester......................... 72
Figure 3.9 Participant selection of the study.. 78
Figure 4.1 Number of OER users (students) in the first semester 116
Figure 4.2 Number of OER users (students) in the second semester....................... 116
Figure 4.3 GCLC components' effects on use & integration of OERs
into system 264

LIST OF ABBREVIATIONS

AEE: Department of Aerospace Engineering

BIO: Department of Biological Sciences

BIOED: Biomedical Engineering

CE: Department of Civil Engineering

CENG: Department of Computer Engineering

CHE: Department of Chemical Engineering

CORE: China Open Resources for Education Consortium

DPT: The State Planning Organization

EE: Department of Electrical and Electronics Engineering

ELE: Department of Elementary Education

ENVE: Environmental Engineering Department

FDE: Department of Food Engineering

GCLC: General Chemistry Laboratory Course

GENE: Department of Molecular Biology and Genetics

GEOE: Department of Geological Engineering

IE: Department of Industrial Engineering

ME: Department of Mechanical Engineering

METE: Department of Metallurgical and Materials Engineering

METU: Middle East Technical University

MINE: Department of Mining Engineering

MIT: Massachusetts Institute of Technology

OCW: OpenCourseWare

OECD: Organization for Economic Co-operation and Development

OER: Open Educational Resources

PETE: Department of Petroleum & Natural Gas Engineering

PHED: Department of Physical Education

PHYS: Department of Physics

TÜBA: Turkish Academy of Sciences

TÜBİTAK: The Scientific and Technological Research Council of Turkey

UADMK: National OpenCourseWare Consortium

UNESCO: United Nations, Educational, Scientific and Cultural Organization

YÖK: The Council of Higher Education

CHAPTER 1

INTRODUCTION

This section entails a framework for the research by offering background of the study, problem statement, significance of the study, purpose of the study, research questions and definitions of the terms for the study.

1.1 Introduction

Open Educational Resources (OER) movement has affected educational practices since it was announced in UNESCO Forum in 2002. Since 2002, many initiatives have been applied through international (OpenCourseWare Consortium), nationwide (CORE, UADMK etc), institutional base (MIT, Carniage Mellon, Open University, Utah State University), and individual base within the contribution of international organizations such as UNESCO, The World Bank, OECD, The Commonwealth of Learning and The European Union (Taylor, 2007). Geith and Vignare (2008) propose that OER in higher education is a part of the learning system that gets new perspective for the virtual and physical classroom environment. The studies through OER focuses on different perspectives in terms of the incentive and disincentives of OER, challenges and strategies for the adoption of OER and policy implications, and impact studies.

OpenCourseWare initiative, which was first put forward from MIT in 2001, shares the similar background with OER and constitutes a specific part of OER movement. Arendt and Shelton (2009) emphasized that through OCW, "the practice of offering traditionally private educational materials openly to the public is new especially full course materials so that OCW materials may be perceived as a new method of learning, particularly self-directed learners" (p. 5). There are numerous OCW initiative that is offered by institutions in worldwide (MIT, Stanford, Berkeley, Open University, UK, METU, Atatürk University etc.). Through the new practices related with the distribution of OERs though different platforms and movements like OCW, MOOCs and personal or organizational platforms; different type of OERs has been developed (videos, simulations, courses, textbooks etc.) and has been used in educational area in practice (Hilton III, 2016). OERs provides many benefits for setting a bridge between face-to-face and online courses (De Liddo, 2010), increasing the quality and visibility of university courses and programs, reputation of the faculty members and the individual learning of the students (Xia, 2011), reducing costs (Phelan, 2012) and providing easy access to freely available materials, flexible learning environment, online interaction between the learners and instructions, online assessment opportunity that improve the distribution of the quality of education (Okonkwo, 2012). Beside these advantages, many barriers are valid for the practices of OERs on educational contexts. The studies in this area have been focused on different use, adoption, implementation practices and impact studies of these resources through personal, pedagogical, organizational and social-cultural perspectives. Therefore, in the next section, the studies, which focused on the problems in OER practices, were provided to display the rationale behind the problem of interest in this study.

1.2 Background of the Study

1.2.1 Awareness and the Use of OER

Students constitute a fundamental part of the OER movement both for the usage and the adoption practices of OER. Based on the reflections related with the students' part of OER movement, Hylen (2005) argues that motivation and the purposes of the students and instructors to involve OER process are still complex and vague. According to the study of Godwin and Andrew (2008), students are separated by their motivations to use OER that there are two types of students that seek the social communication (social learners) and formal education (volunteer students) through

OER so that the purposes of the OER use have differentiated students' motivations. Moreover, based on the Oxford University's OER Impact Study (Masterman & Wild, 2011), the results of students' perceptions and purposes through OER movement reveal that there is a lack of awareness of OER, they preferred to use current online materials rather than printed one and also the increase on the information literacy perception and on demand for creating own resources. Similarly, Panke and Seufert (2012) point out that the awareness and integration of OER in students' formal learning process is quite low in universities.

Mackintosh (2012) proposed that the open practices have a power to include the learners in higher education so that it is important to implement open practices in educational process successfully (cited in Murphy, 2013). Findings from MIT's Evaluation Report (2006) reveals that students and educators emphasized that OCW material's impact and quality are high level. However, Kozinska et al. (2010) criticized the right design process of OER that through the different learner purposes, creating the design process might be a challenge. OER practices have an impact for both students and instructors so that there is a need to clarify students' needs and preferences for the use of OER in order to implement open practices in higher education.

Through the instructors' side, the importance of academic staff for the OER movement is also emphasized as supporting sustainability and the quality of the process. (D'Antoni, 2008). According to the OER impact study (Masterman & Wild, 2011), the results revealed that teachers have a lack of OER perspective and license policies within Creative Commons. In addition, according to the study of Rolfe (2012), while most academic staff did not hear the OER movement, they were eager to share their course materials. However, teachers interpret the use of OER as beneficial in terms of easy integration for the student's learning environment, pointing out learner's specific needs and improving their self-learning practices, enhancing teacher's own practices and increasing the collaborations between teachers and learners. In addition, teachers tend to prefer integrating OER into formal teaching through multimedia (videos, simulations, virtual environment) as a supplementary role. In addition, Kursun (2011) argues that the faculty member’s unwillingness to share their materials, lack of awareness and technical support are the main challenges for the adoption of OER through faculty members’ side.

Based on UNESCO (2011) report, some suggestions were provided for academic staff in terms of increasing the knowledge for OER, publishing materials, adapting OER through collaborative working, encouraging the use of OER and evaluating OER practices. However, while the free access to the learning resources provides diverse sources of information, effective use of these resources is still a challenge for students, teachers and administrators (Panke & Seufert, 2012).

1.2.2 Adoption of OER

After the determination of OERs, different practices were applied to adopt and integrate the OERs into educational contexts. Chen (2010) defines the fundamental issues related with the OER research as the understanding of the integration of the OER into institutions and strategies for the facilitation of the usage process. Based on UNESCO (2011) study, four factors were determined through the adoption of OER in terms of pedagogic (provenance-quality, pedagogic intent, granularity, media), attitudinal, logistic and strategic. Pedagogic factors are considered as the quality of the material, the purpose and the type of the material, granularity (focusing on the little OER that covers the simulations, videos, texts), and validity and reliability of the resources. In addition, the attitude of the faculty members and teachers, logistical problems (search characteristics of OER and awareness of license procedures), and individual and cooperative practices especially affect the adoption of OER.

Besides the adoption of OER into instructional process, there are also some practices the adoption of OER in institution or organizational base. The Centre for Educational Research and Innovation identified four main barriers for the adoption of OER in terms of technical barriers (problems in the internet access), economical barriers (developmental costs of the materials), social barriers (social skill and the interaction between communities) and legal barriers (copyright issues and policies) (Arendt & Shelton, 2009). In addition to this barriers, also providing the sustainability is a major challenge because the cost of course in MIT's OCW approximately 25.000$ (Atkins, Brown & Hammond, 2007). Similarly, the barriers for the adoption of OER are classified as technical, economic, social, policy-oriented and legal (OECD, 2007). The cost and technical requirements for creating and publishing OER, social deficiencies for using and sharing OER, and license results in the challenges for OER movement. In similar vein, the factors that might affect the adoption of OERs were related with the quality of OERs (improving students' success and learning and being cost effective), faculty members' qualifications for OERs' 4R features and the supports for faculty members (value of resources and grants and funding for OER practices) (Coleman-Prisco, 2017). Related with the faculty members' familiarization of open practices, although there is a growing trend for using OER, there is still lack of awareness for the open aspect of OER (Karunanayaka, Naidu, Rajendra & Ratnayake, 2015; Belikov & Bodily, 2016) and adoption of them to traditional environments. As Farrow et al. (2015) highlights that most participants have lack of interest on open licenses, which may have resulted in lower adaptation by revising or remixing the content. Use and adaptation problems are also related with the knowledge and perception of faculty for OERs (Kursun, Cagiltay & Can, 2014). In order to overcome these problems, some studies point out that universities generate some policies to adopt and encourage to use OER by creating awareness by workshops, supporting faculty members for their ICT skills and cooperating with different institutions to generate resources and new policies (Kursun, Cagiltay & Can, 2014; Muganda, Samzugi & Mallison, 2016). Similarly, faculty members also need to be informed about OER to design, use and adapt the resources for their students (Belikov & Bodily, 2016). Moreover, Hu et al (2015) also suggested some strategies for the adoption of OER as providing more attractive and user-friendly environment on resources to increase the use, and organizing orientations for new students to online learning as an alternative for traditional environment.

Beside these practices and researches, Chen (2010) defines a challenge as the lack of information related with the integration of the OER into the instructional process. Deimann & Farrow (2013) pointed out that the open education has not yet reached a theoretical framework. Similarly, the adoption of OERs (Murphy, 2013) and OER implementation strategies (Jung, Bauer, Heaps, 2017) are still indefinite areas. Therefore, the adoption of OER into educational context is a shallow area that requires several practices and researches.

1.2.3 Impact of OERs on Teaching and Learning Practices

There are some impact studies in formal educational setting mainly focusing on adoption of open textbooks. There are also some studies especially focused on non-grade related performance effects on students and teachers' experiences and activities. According to the findings of OER Research Hub project from both students and educators' perspective, the impact of OER on students' performance indicated as increase on satisfaction, interest and engagement with learning experience, increase on test scores, support for new ways of learning, and expand the knowledge on different contents (Weller et al, 2015). The impact of OER on educators' performance, on the other side, revealed to "better accommodate diverse learner needs, to broaden their teaching methods, and to reflect more on the way on teaching" (de los Arcos et al, 2016, p. 37) which could be beneficial to enhance their teaching methods and to be more reflective on their and students' learning, teaching strategies and assessment techniques on the course (Pierce, 2016). In addition, they also highlight the teachers' perceptions on students' performance within the impact of OER by defining them more self-reliant and engaged learners. Moreover, Pitt (2015) explores the impact of OER on teaching practices as changing pedagogical approaches, having updated knowledge and confidence at least and making easier to teach the content. In line with these, Kursun (2011) found that OER is especially beneficial for establishing scaffolding for inexperienced faculty to design their courses and providing the opportunity to learn from experienced faculty.

There is also an interest in OER studies related with science learning and practices (Scanlon, 2012). Regarding science learning and teaching, laboratory courses constitute major element for students' learning and teaching activities (Hofstein & Lunetta, 1982) and they are seen as more interesting practical environment than the course itself (Broman & Simon, 2015). Between different laboratory courses, General Chemistry provides an opportunity for different disciplines to have skills and experience for their profession in line with chemistry education (Figueiredo, Neves, Gomes & Vicente, 2016). The major problem is to design the course for students in other disciplines as meaningful and practical for their profession which can be solved by designing the course by aligning the students' needs and expectations with faculty goals and objectives (DeKorver & Towns, 2016) and by supporting scientific thinking and empirical testing (Reid & Shah, 2006). Another problem regarding laboratory courses is related with the level of experience of students and teachers in their profession. Many freshmen students have problems with the confidence and stress levels for new chemistry laboratory courses (Dalgarno, Bishop, Adlong, Bedgood Jr., 2009). In order to minimize this problem, Cooper, Kenny and Fraser (2012**)** find out that science teaching resources positively affect pre-service teachers' self-confidence, experience on teaching in the future.

As seen in the literature, there are some problems, which are related with impact of OER and adoption of them in formal education context. In this field, while most studies are focusing on the design and utilization of the resources, there is still need for reliable impact studies (Weller et al, 2015). Regarding this impact, rather than grade, cost and access effects, non-grade related effects could also be beneficial for students and educators. Moreover, the use and possible impacts of OERs on science education and learning could provide a lens to eliminate the problems related with the science laboratory courses. Therefore, this study can provide a comprehensive picture for the use and impact of these resources in formal education context through observing the impact over time. Specifically, this study can provide a lens for using and integrating these resources into science laboratory courses context by combining with the problems in itself and the impact of these resources. In addition, this study could promote more in depth studies that focus on specific discipline or courses to observe the impact in formal education settings.

1.3 System Theory as a Framework for this Study

System theory has been used in many disciplines to reach the unified reality for natural and human-constructed worlds, which hold the change and complexities in inside (Chen & Stroup, 1993; Banathy & Jenlink, 2004). As the pioneer of the system theory (General Systems Theory/GST), Ludwig Bertanaliffy proposed GST especially for the practices in education in 1955 (Chen & Stroup, 1993). Systems theory with other two components systems philosophy and systems methodology, which constitutes the systems inquiry, they provided a path for the evolution of systems movement (Banathy, 1988). This systems movement or approach was proposed to provide benefits for having a wider perspective for the description and analysis of the systems (Stowe, 1973). This movement has affected many fields and disciplines over the years as hard system science, cybernetics, social systems and human systems. Among these systems, educational context are mainly related with the human systems, which include the purposeful activities or functions made by people (Banathy & Jenlink, 2004). However, in educational context different from the other disciplines used the system inquiry like business, industry, healt services, engineering and other disciplines, systems inquiry has not been using as a theoretical lens to describe, explore and analyze the educational context from system perspective (Banathy & Jenlink, 2004). Because of the complex and dynamic nature of educational contexts, systems methodology could provide best approach to analyze the context (Stowe, 1973). Thus, systems view of education of Banathy (1992) proposes could provide a comprehensive and detailed roadmap on how to describe and analyze the educational context. In similar vein, Walton (2004) described Banathy’s three models as successful to have a more detailed and holistic approach for the systems as to help to understand the system in each level and to enable the researcher to decide on how to work with the model. Therefore, in this study, the system (case) was not the primary interest but it helped to understand the problem of interest. Thus, throughout of this study, these three lenses were followed to represent the description of the system or case because without the general picture and insight of the system, the problem of interest could not be refined in a comprehensive way.

1.4 Problem Statement

As mentioned in the background of the study part, there is a limited understanding of the students' purposes and motivations for the use of OER in their instructional process. In addition, there are some problems within the instructors' perspective for the use of OER in their course process in terms of lack of awareness, technical support, and confidence through the instructors and teaching assistants' fundamental role for the integration of OER.

The second problem is related with the lack of awareness for the adoption of OER into educational context and the lack of a theoretical framework for OER practices. Therefore, while examining the students', faculty members' and teaching assistants' experiences through the use of OER, some fundamental factors and clues for the use and integration of OER into science laboratory course context were clarified.

The third problem is related with the lack of understanding for the impact of the OERs on teaching and learning activities. Specifically, within the growing trend of using OERs in science education contexts, the impact of these resources on science related disciplines and courses requires new studies and practices in this area.

1.5 Purpose of the Study

Both OER and OCW have an impact on educational process but the important thing here is to clarify the scope, breadth and depth of this impact (Arendt & Shelton, 2009). The first purpose of this study is to provide a detailed perspective for the use and integration of OER into science laboratory courses through the students', instructions' and teaching assistants' perspective. More specifically, why and how students, instructors and teaching assistants use OER, the components and policy practices which could possibly affects the use and integration of OERs in a small scale course system constitute the first purpose of this study. Corter, Esche, Chassapis, Ma and Nickerson (2011) suggested that the integration of new technologies into science laboratory courses should be evaluated with new studies. Therefore, through this study, especially educational aspects rather than institutional aspects are aimed to provide for the use and integration of OER into science laboratory courses.

The second purpose of this study is to provide an understanding for the impact of OERs on teaching and learning practices in chemistry laboratory course. Murphy (2013) criticized that there is a need to determine students' success through an educational framework and each OER implementation should be evaluated based on its own context. Thus, in this study, the impact of OERs was especially provided within the scope of the chemistry laboratory courses in higher education institutions.

1.6 Significance of the Study

This study could provide significant results from two directions: first, it could provide a holistic picture of the extent to which the OERs were used in laboratory courses; second it could provide data for the impacts of OERs on practical courses rather than lectures in educational contexts.

For the first, within the use of system theory as theoretical framework, this study could provide a roadmap of how the resources could be influenced by the contextual and environmental issues in the course system. In addition, this study could provide a roadmap for teachers and administrators to evaluate the effectiveness of these resources by using profiles. Forward (2012) criticized that there is a lack of visibility of the OCW's impact because the purposes and the characteristics of OCW users are unknown. Moreover, this study could provide insights for further adoption and integration of OERs aligned with curriculum and provide some suggestions to improve the policy practices for the implementation of OERs while the need for research should be about learner's use and adoption of OER (Panke and Seufert, 2012) and OER' implementations strategies (Jung, Bauer & Heaps, 2017). Knox (2013) argues that the

OER movement is understood as removing the barriers for the use of OER rather than involving the freedom itself so that practitioners and researchers could miss the pedagogical aspect of the movement. Similarly, recent teaching models and research have been criticized that the institutional, pedagogical and cultural aspects of the adoption of OER should be focused on rather than the resources themselves especially new pedagogic approaches should be followed (Deimann & Farrow; McAndrew & Farrow, 2013). Because as McAndrew and Farrow (2013) criticized “the recent growth in interest in OER has several drivers, ideological, political and economic, none of which in itself explains how learning will be supported or help us to develop effective models and learning design” (p. 65). For that reason, in this study, the purpose is to provide a complete picture of how to use and integrate OERs into science laboratory courses within the educational aspect rather than examining the barriers and challenges of the adoption of OER into science laboratory courses. Most of the studies mainly focused on the adoption of OERs, but the limited findings are apparent related with the current use and integration of OERs into a course system after the resources were created. Moreover, the studies related with the resources (simulations) do not focused on the teachers’ role and the resources’ place on the curriculum (Rutten, van Joolingen & van der Veen, 2012) and there is a limited literature on the adoption of OERs for virtual labs (Raman, Achuthan, Nedungadi, Diwakar & Bose, 2014). Therefore, while there is not a common understanding of why students prefer to use OER (Arendt and Shelton, 2009), and why and how the users (Hylen, 2005) involve the process of OER. Thus, this case study could provide a detailed picture of how and in what ways students, faculty members and teaching assistants use OERs in their science lab courses for the future implementations of OCW and OER. Moreover, Kursun (2011) identified the faculty members as the key elements for the OER Movement. Thus, in this study, beside students, faculty members and laboratory teaching assistants were added into the study because they constitute an important part for the adoption of OER into chemistry laboratory course practices.

For the second, most of the impact studies focused on the OERs used in formal education contexts especially related with the open textbook adoption studies (Farrow, de los Arcos, Pitt & Weller, 2015). However, the studies were lack in the courses, which requires practical experimentations (Elf, Ossiannilsson, Neljesjö & Jansson, 2015). Moreover, Forward (2012) argued that statistical data comes from website analytics (number of visitors, time spent on websites and geographic origins) does not provide a detailed description of the impact of OERs. From this perspective, this study could provide a roadmap for designing the resources based on the students' experiences through learning domains and evaluating the impacts of the resources from learning domains. Moreover, this study could provide some suggestions for design and development features of OERs to improve the quality of these kinds of resources. Therefore, this study could enlighten different studies through a different type of resources (videos and simulations) in different educational settings (chemistry laboratory environment) rather than the impacts of textbook adoption in educational settings.

1.7 Research Questions

This study will investigate the following main research and sub research questions:

1) Which factors influence use and integration of OERs into chemistry laboratories?
    a. Which factors represent the usage behaviors of OERs through the lens of preparedness for the laboratory course?
    b. What do lab assistants and students experience during the implementation of science lab courses, which could possibly be related with the implementation of OERs?
    c. How do policy practices promote the use and integration of the OERs into the science laboratory environment?
2) How do the utilization of OERs facilitate the students and research assistants' perceived performances through the laboratory course?

1.8 Definition of Terms

Openness: Tuomi (2006) classifies openness through three perspectives in terms of technical (lack of interoperability and unavailability of technical specifications), social openness (copyright policies, accessibility, and geographical area) and the resource itself.

Open Resources: open resources are defined as:

> • "sources of services that do not diminish their ability to produce services when enjoyed.
> • Provide non-discriminatory access to the resource.
> • Can be adjusted, amended and shared" (OECD, 2007, p. 37)

Open Educational Resources: The definition is:

> *OER are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge* (Atkins, Brown & Hammond, 2007, p. 4).

OpenCourseWare: It is a specific initiative based its roots on Open Educational Resources perspective that requires to freely share the course materials through worldwide.

Integration of OER: The process of using open educational resources in formal education context. In this study, the practice was selected as the chemistry laboratory course.

Instructors/Faculty Members: Individuals in higher education institutions that are responsible for the research, teaching and learning practices and support for students.

Laboratory Teaching Assistants: Individuals in higher education institutions that are responsible for the research and teaching practices in science laboratory courses.

Simulation: Imitation of acts, objects or processes of real-life scenarios, events, processes or situations

Performance: The result of an act, which defines how well any kind of activity achieved or completed.

Perceived Performance: Self-evaluation of performance through the students and teaching assistants' perspective in this case.

Policy: Plans, standards or guidelines, which orients what to do or implement in a particular situation.

Teaching and Learning Activities: Any kind of activities or practices, which include teaching process (teaching method, styles etc.) and learning process (communication, discussion, interaction etc.)

CHAPTER 2

REVIEW OF THE LITERATURE

This chapter describes the findings and implications in the literature regarding the research questions of this study.

2.1 Open Educational Resources

Open educational Resources was first mentioned in the *Forum on the Impact of Open Courseware for Higher Education in Developing Countries* by UNESCO in 2002 (D'Antoni, 2008; Duval & Wiley, 2010; Murphy, 2013). There is not universal definition of OER, but the common definition is:

> *OER are teaching, learning, and research resources that reside in the public domain or have been released under an intellectual property license that permits their free use or re-purposing by others. Open educational resources include full courses, course materials, modules, textbooks, streaming videos, tests, software, and any other tools, materials, or techniques used to support access to knowledge* (Atkins, Brown & Hammond, 2007, p. 4).

Similarly, the materials and equipment that used within OER "full courses/programs, course materials, modules students guides, teaching notes, textbooks, research articles, videos, assessment tools and instruments, interactive materials such as simulations, role plays, databases, software, apps (including mobile apps) and any other educationally useful materials" (Olcott, 2012, p. 284). In these definitions, two main elements emerge as free use of the resources under the license protocols and the type of the resources. Type of the resources are diverse that enable users to freely benefit from these materials.

The second element of OER was defined as freely accessible, licensed resources and their open and reusable codes (Murphy, 2013). Butcher (2009) describes the OER as freely available resources that are shaped by common license without payment and fees. *Creative Commons* license enable the users of OER to determine their activities into some rules through “4R” activities. These activities are defined in terms of reuse, revise, remix, and redistribute (Duval & Wiley, 2010; DeVries, 2013). This license provides a more flexible guideline depend on the nature of the OER rather than the standard copyright license (Deimann & Farrow, 2013). Through this license, a guideline is provided to get a common underground for the use of OER in worldwide

Openness in higher education trend provides some other terms and movements in terms of open content, open source software, open courseware, open access (Murphy, 2013). Between them, open educational practices are the second phase of OER movements that “support the creation, use and managements of OERs through institutional policies, promote innovative pedagogical models and respect and empower learners as co-producers on their lifelong learning path” (Murphy, 2013, p. 202). Ives and Pringle (2013) point out that through OER movement, new approaches for the development and design of the courses get a broader perspective for the online learning environments. However, Olcott (2012) criticized the term OER that “OER is not synonymous with the terms of online learning, e-learning, mobile learning. Many OER-while shareable in digital format-are also printable” (p. 284). Different from distance and online learning, OER advocates the free use of materials in both formal and informal learning environments through online or face-to-face interactions (Geith & Vignare, 2008). Therefore, OER has a different perspective for dissemination of the instruction.

Through worldwide, different initiatives and practices were applied through OER movement. Different platforms and ways are valid which share different OERs. Wiley, Bliss and McEwen (2014) described three types of OER sharing as individual sharing with metadata in some platforms (OER Commons and MERLOT), sharing as textbooks (Flat World Knowledge, Connexions, CK12) and course-like sharing as OCW websites. Some of these initiatives were provided in detailed below.

MIT OCW: In 1999, MIT began to improve OCW initiative and launched this initiative in 2011 (Abelson, 2008) within 1,890 courses through OCW (Davis et al., 2010). OCW initiative considered as the representation of the OER movement (Abelson, 2008) and course format of OER perspective. MIT OCW initiative is the most popular one that receives 2.086 million visitors on September 2017 and 2413 courses published at all (MIT Monthly Report, 2017).

OpenLearn: In 2006, UK Open University's Open Learn project launched two features, which unifies two different environments for the users (LearningSpace) and creators (LabSpace) that while LearningSpace provide users the course materials, LabSpace enables learner to create their own materials. Then, LabSpace transformed into OpenLearn Create, which enable users to create their own materials (OpenLearn, 2017)

OER Commons: A project created by Institute for the Study of Knowledge Management in Education (ISKME) which provide many OERs and also enable the users, researchers, instructors to create, adapt and share the OERs through a collaborative community of practice.

Connexion: Different from MIT's OCW project and UK Open Learn, Rice University's Connexion project provides a free platform that enable the users to create, share the courses within the collaboration of other users in worldwide (Atkins, Brown & Hammond, 2007; Kursun, 2011). This initiative was founded as OpenStax (then the name of Connexions and now OpenStax CNX) by Dr. Richard Baraniuk to provide a platform for users to create, share and adapt many educational content (OpenStax CNX, 2017).

COSL: Center for Open and Sustainable Learning (COSL) which is provided by Utah State University provide users a free platform (eduCommons) that help learners to operate their material sharing process by reducing the copyright and cost barriers (Atkins, Brown & Hammond, 2007). In addition, within this university, Utah State Open Learning support (OLS) website offers users a collaborative environment to interact with other users.

TESSA: Teacher education in Sub-Saharan Africa (TESSA) initiative provides course design models and learning objects for teachers from different disciplines through four languages (Butcher, 2009)

In addition, there are numerous articles, books, Open Access journals (e.g Textbook Revolution) provides freely accessible resources for the users around the world. Open Textbook and Open Access Journals emerges in 1990s and both have important effects on the research area (Kursun, 2011).

2.1.1 OpenCourseWare

In 1999, an important approach (OCW) was announced (Kozinska et al., 2010). MIT created OpenCourseWare project that provides an area for universities to publish virtual courses all around the world (Xia, 2011). OCW is provided through institutions via multiple ways in terms of university's OCW server, in repositories or through content providers (Forward, 2012). Based on OECD study in 2007, in more than 300 universities more than 3000 courses were published worldwide (D'Antoni, 2008; Geith & Vignare, 2008). In September 2017, approximately 245 million individuals visited the MIT's OCW site (MIT Monthly Report, 2017).

OCW movement creates and offers a *parallel universe* for the problems in higher education beside the current educational models (Tylor, 2007). The free publication of course materials can provide alternative ways for students to benefit from the courses. Carson, Kanchanaraksa, Gooding, Mulder and Schuwer (2012) propose that OCW can provide an effective bridge between learner's informal and formal learning. Similarly, Wilson (2008) points out that "OER and OCW might not give formal education qualifications but act as a supplementary element in helping people gain knowledge through either instructor-led or dependent studies" (cited in Kozinska et al, 2010, p. n.d). Therefore, OCW and OER lies on a powerful idea that provides a different angle on the practices for teaching and learning (Forward, 2012). Therefore, OCW does not aim to take the place of formal learning but it helps to provide a different perspective for the integration of formal and informal learning environments. In addition, OCW has as an effect on the preparation for the exams and selection of the courses and institutions (Carson et al., 2012) so that OCW could give a reputation for both institutions and courses provided. OCW Consortium

OCW Consortium is defined as " a collaboration of more than 200 higher education institutions and associated organizations from around the world creating a broad and deep body of open educational content using a shared model" (Butcher, 2009, p. 2). More than 280 institutions and organizations from 45 countries are members of OCW consortium in order to share their OER experiences and movements (Open Education Consortium, 2017)). In addition, there are so many organizations and initiative that provides open education content in nationwide in terms of CORE (China Open Resources for Education Consortium) (30 institutions in China), Japan OCW Consortium (9 institutions) and Spain and Portugal's OCW Universia (14 institutions) (Arendt & Shelton, 2009). In Turkey, Turkish Open CourseWare Consortium (UADMK) under the Turkish Academy of Science (TUBA) has been carrying out its mission since 2007 in order to unify different institutions within OER movement.

2.1.2 OER Movement in Turkey

Kursun (2011) classified the OER initiatives in three groups in terms of the nationwide, institutional and personal initiatives in Turkey. First category includes the Turkish OpenCourseWare Consortium (UADMK) under the Turkish Academy of Science (TÜBA) that this consortium aims to provide OER within the collaboration of the universities. In 2007, a meeting was held by the leadership of TÜBA with 24 universities, TÜBİTAK, YÖK and DPT for the OER project in Turkey and in 2010, 26 courses in basic sciences were offered within UADMK website and also, 21 courses were translated into Turkish (20 courses from MIT and 1 course from Utah State University. In addition, the number of universities for the participation of UADMK membership has increased to 62 from 24 since 2007. There are 35 courses are provided in Natural and applied science category and only four of them are related with the chemistry. Based on the statistics of TÜBA, 86.6% of the courses were supported with pdf files and 10.4% of the courses were supported with the videos (Cakmak, Ozel & Yilmaz, 2012).

In institutional phase, 8 universities provide OER initiatives (Atılım, Ankara, Başkent, East Mediterrian, Gazi, Hacettepe, METU and Sabancı University) but only in Middle East Technical University, the general chemistry course materials are provided through METU OCW portal through Turkish and English versions. Scanlon (2012) stated that the OER movement affect the science learning and creates *The Open Science Movement* that enables more transparent and comprehensive science. Therefore, this chemistry course provided a picture how a science course can be designed based on OER perspective. In addition, this course was awarded through OCW Consortium Awards for OpenCourseWare Excellence within the video and multimedia category in 2011.

2.2 Use and Integration of OERs

Open educational resources have created a popular movement in educational practices over years. Its open and free nature enables the stakeholders in educational area to create new instructional approaches. Thus, its use and integration of educational settings resulted in diverse research and findings in the literature.

Regarding the use of OERs, while most of the formal users were using OERs to support their formal study, informal users were using to have low cost study instead of formal education (de los Arcos et. al., 2014). In addition, the reasons to use OERs were also diverse as interest on study subject, professional development, improvement on study skills; support the studies (Farrow et. al., 2015) and assistance on personal learning (Hu et. al., 2015) while easy to access and minimum cost of the OERs played a vital role for these purposes (de los Arcos et. al., 2015). From the teachers' side; the teachers were benefitted of OERs for the inspiration, preparation and supplement of teaching practices (de los Arcos et. al., 2015). However, many barriers for the use of OER were identified in the literature. From the users' side, based on the findings of a research, people are familiar with OER but do not actually know how to use them (Okonkwo, 2012). From the instructors' side, Hylen (2005) mentioned the main barriers for the use of OER in terms of copyright issues, quality of the resources, and sustainability.

Regarding the adoption and integration of OERs, many problems were emerged in the literature. Some studies reported that the problem related with the OER use and integration in the classroom is about the lack of information on how to integrate OERs into classroom (The Boston Consulting Group, 2013; Belikov & Bodily, 2016). BCG report also showed that educators generally used OERs as supplementary materials, and the primary usage was approximately 10%. As seen in Figure 2.1, three integration ways were formularized and the most preferred one is using as a supplementary resource through the formal education. Therefore, OERs still not comprise full course components as assessment, feedback and support; they mainly served as online materials generally for course contents (DeVries, 2013). The reason of lack of integration could be discussed in different terms but the quality and the content of the OERs could be essential to keep in mind. While the quality of OERs still a problem for the integration of OERs (BCG, 2013; Pierce, 2016), the quality also affected the future use, discovery and advertisement of OERs (Pitt, 2015). This inference also in line with the idea that some practices was still favor of traditional instructional materials (e.g. textbooks). Another problem of the quality of OERs highlighted the content and objectives of OERs. While most of OERs were still suffered from the lack of clear learning objectives of the courses (DeVries, 2013), the alignment of the learning objectives of the course with the OERs is a challenging process which could underestimate the potential of OERs beside traditional textbooks with aligned objectives (Pierce, 2016).

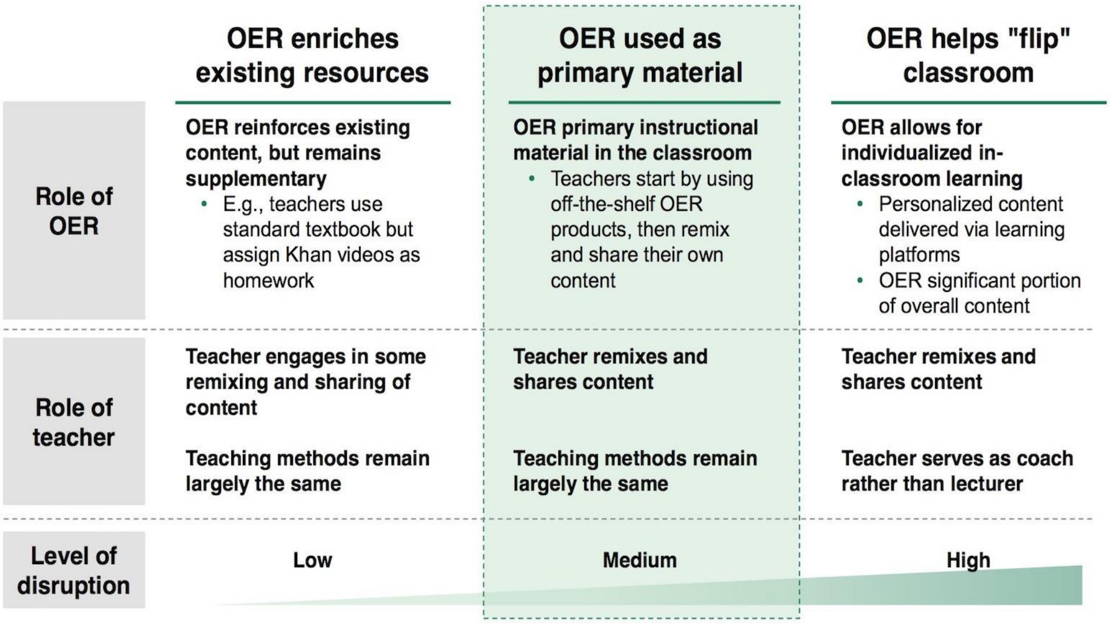

Figure 2.1. OERs in classroom as a mainstream (The Boston Consulting Group Report, 2013, p. 2)

In line with the integration of OERs, the adoption practices also created challenges for the OER usage and implementation. De Liddo (2010) criticized that while the diffusion of OER movement has the worldwide effect, the adoption of OER practices into educational context is still in low level. Judith and Bull (2016) categorized the challenges of implementation of OERs into higher education as contextualization (to localize the content based on students' needs and the scope of the course), identification (to find qualify resources), discoverability (to find appropriate resources), user-permission (to have copyright concerns) and knowledge-related (to have lack of experience on how to integrate OERs). In order to eliminate these challenges, four strategies were provided as personalized (educators could learn the specific details by themselves), programmic (workshops or training could be arranged for the integration practices of OERs through educators' professional development or providing tools for educators on how to decide the user permissions of OERs), institutional (more broader sense of allowing students, faculty and staff's experiences for improving OER practices) and networked strategies (allowing the community based aggregations on discussing the practices of OERs by different stakeholders as educators, content developers, administrators, instructional designers etc.) (Judith & Bull, 2016). One of the major challenges of OER implementation is the lack of awareness about OER ecosystem; while awareness of OERs are increasing and showed 50% or more awareness of OERs, still some professors and majority of staff were not aware of OERs (Rolfe, 2012; BCG, 2013). Similarly, Olcott (2012) emphasize the barriers for OER use as the resistance of the faculty members and teachers for the use of OER and the lack of awareness of both teachers and learners of the OER movement. Moreover, one of the purposes for this issue is that the teachers prepare their courses and materials according to their way and style (De Liddo, 2010). As the policy practices provided leading patterns for OER integration, the institutions and developers had major roles to increase the awareness of OERs for students (Hu et. al., 2015). They also could have a supporting role for finding and evaluating the new resources within the collaboration of library of different units support (technology or teaching support offices) (Belikov & Bodily, 2016). Related with these practices, Richter and McPherson (2012) also propose a model for the adaptation and reuse of OER and they give some recommendations:

- "Providing printable version of the learning resources
- English abstract should be provided
- Resources should include combination of pictures and text in changeable format
- Republishing of adapted resources should be encouraged
- Resources should meet the need of both the teachers and learners
- Context description of the resources should be provided" (p. 214).

Through these barriers, language constitutes an important gap for the distribution of OERs because the distribution of OER does not end with the transformation of languages but also includes awareness of the cultural diversity and contextual issues (Xia, 2011; Richter and McPherson, 2012). Similarly, Richter and McPherson (2012) determine the main challenges of OER movement from different perspective as whether these resources support the learners' needs and purposes, possibility of different meanings in different languages and also the lack of knowledge how to adopt and evaluate OER through a course design model. In order to overcome this problem, OCW Consortium translates the educational resources into different languages in different countries in terms of Spain, Portugal, Venezuela, China, Japan, Korea, Iran, Vietnam and France (Geith & Vignare, 2008). Xia (2011) point out another concern with the term "granularity" that defines how many parts of a content should be shared or reused. In OER movement, there is not a common protocol for the shareable pieces of the resources so that this decision could be challenge for the users.

OER can provide a structured framework as similar with the non-educational learning environments in a formal education context (Lane & McAndrew, 2010). Through this view, OER can provide practices to integrate non-formal or informal practices into formal structures (McAndrew & Farrow, 2013). OER supports a structured model in order to share and redesign the higher education programs for both faculties and academics (Butcher, 2009). In addition, OER provides faculty members to create and organize their work through sharing and designing the learning materials (Butcher, 2009). However, the problems and barriers are also valid for sharing the materials. Kursun (2011) defines the main problems with the faculty members are the lack of awareness how to apply copyright issues and the lack of confidence for their material's quality. De Liddo (2010) provides a rationale for the barriers to OER as the lack of people's apprehension of open thinking concept. Open thinking could be perceived as the openness for the different perspectives and perception of the visibility and flexibility so that the lack of open thinking could be a rationale for the resistance of the faculty members. Olcott (2012) point outs two different types of OER used in higher education in terms of formal and non-formal. While formal OER use requires using credits or certificates for the courses in OER, non-formal OER requires integrating OER into courses with optional choices. Olcott (2012) emphasize that in more universities, faculty members integrate OER in order to provide diverse learning resources. Moreover, Tuomi (2013) identifies 4 types of OER in terms of OER I (only free access to resources), OER II (free access to resources to get credit or certificate), OER III (free access to modify or change the resources) and OER IV (free access to redistribute the resources) and most of the OER initiative are categorized under OER I type. In Middle East Technical University, especially for the chemistry course, non-formal type of OER is implemented. The resources are free to use and provided as a supportive role for the formal courses. In addition, based on the Tuomi's classification, OER I type is implemented that the resources are only allowed for the free access and use.

2.2.1 Use of OER in Science Laboratory Context

2.2.1.1 Science Laboratory Instruction

Tobin (1990) defines laboratory activities as "a way of allowing students to learn with, understanding and, at the same time, engage in a process of constructing knowledge by doing science" (cited in Hofstein & Lunetta, 2004, p. 32). The similar version of lab work was defined as the "subset of all practical work performed in the laboratory, which may include demonstrations and computer simulations in addition to hands on experimental work" (Deacon & Hajek, 2010, p. 944). Science laboratory activities are one of the main components of science education that enable learners to work in an active experimentation (Hofstein, 2004), to have diverse learning benefits (Hofstein & Lunetta, 2004); and constitutes an important part of the chemistry education practices in higher education (Reid & Shah, 2007; Elliot, Stewart & Lagowski, 2008).

In chemistry laboratory work, there are four styles of laboratory instruction in terms of expository (aware of the outcome-*cookbook* style), inquiry (no outcome-responsible for own learning process), discovery (no outcome), and problem-based (aware of outcome-responsible for own learning process) (Domin, 1999; Johnstone & Al-Shualili, 2001; Hofstein, 2004) (Table 2.1). Between these design types, expository model is the most common and traditional one (Domin, 2007). The criticisms about the effectiveness of these four styles have not yet been finalized that each style have advantages and drawbacks in its nature but no style could support all the desired outcomes (Domin, 2007).

Table 2.1 Laboratory Instruction Styles (Johnstone & Al-Shualili, 2001, p. 45)

Style	**Outcome**	**Approach**	**Procedure**
Expository	Predetermined	Deductive	Given
Inquiry	Undetermined	Inductive	Student generated
Discovery	Predetermined	Inductive	Given
Problem-based	Predetermined	Deductive	Student generated

In literature, the criticism about the role of laboratory work has different results. While chemistry laboratory experiments result in the increase the cost and time spent for the instructors, they can provide an understanding for the association between the theory and practice (Reid & Shah, 2006; Aufschnaiter & Aufschnaiter, 2007; Skoumios & Passalis, 2010) and result in meaningful learning (Hofstein, 2004). Domin (1999) proposed many scientific learning outcomes through the laboratory exercises in terms of “conceptual understanding, retention of content knowledge, scientific reasoning skills, higher-order cognition, laboratory manipulative skills, better attitude toward science, a better understanding of the nature of science” (p. 547). However, in laboratory education, while students try to get the desired outcomes, they miss to observe and criticize what they are doing through the experiments (Reid & Shah, 2007) so that the practical work in laboratory do not have so much change through the years. Reid and Shah (2007) criticized that the absence of the purpose and stimulation of the students for the laboratory work can result in the negative perception of the students for the laboratory courses and also the value of these courses. However, the studies related with the practical work that the students consider them as enjoyable and useful for science education (Hofstein & Lunetta, 2004; Skoumios & Passalis, 2010). However, the laboratory offers many benefits for practical experimentation; some challenges are still valid to inhibit learning as (Hofstein & Lunetta, 2004):

- Expository style of experiential activities through lack of thinking
- Lack of assessment in practical knowledge and abilities
- Lack of information about best contemporary practices and developments in laboratory education
- Technological and technical infrastructures and lack of devoted time of faculty members

The type of laboratory instruction could create different learning outcomes but also the necessity and role of laboratory course is still a debate especially for non-major students (Hawkes, 2004).

2.2.1.2 Supportive Resources for Laboratory Instruction

Recent years, the information and communication technologies (ICT) and multimedia (animations, simulations, videos etc.) have been using in educational contexts so that the chemistry laboratory education is also affected by the use of these resources (Pekdag, 2010; Scanlon, 2011). Open educational resources also played a key role on creating, developing and sharing these resources in different formats in laboratory courses.

Through the new technologies, virtual (simulated) and remote laboratories have gained more interest in science education (Scalise et. al., 2011). While the emergence of two labs have common concerns such as the alternatives for the real lab space and time consumption, they have different purposes for science lab experiences. While virtual laboratories are seen as the supportive practices for the hands-on laboratories (Abdulwahed & Nagy, 2009; Corter et al., 2011) for visualization of the subjects and preparation for laboratory courses (Dalgarno, Bishop, Adlong & Bedgood Jr., 2009); remote laboratories are seen as the alternative for the hands-on laboratories (Nickerson, Corter, Esche & Chassapis, 2007). Ma and Nickerson (2006) defined the simulated laboratories as the imitations of hands-on laboratory activities that provide valuable experiences for learners. Virtual laboratories can help students to control their learning process through the support for the real laboratory experiments (Tatli & Ayas, 2012) and repeat the experiments for a meaningful understanding (Abdulwahed & Nagy, 2009). However the giving chemistry courses through online channels is still a challenge for the instructors (Brewer, Cinel, Harrison & Mohr, 2013) even if the cost of laboratory equipment, safety issues, environmental constraints and devoted time for actual experiments are still challenging issues for laboratory instruction (Scalise et. al., 2011).

Before applying the hands-on laboratories, virtual laboratories could be provided for students to decrease the practical challenges (Barros, Read & Verdejo, 2008), which could be dangerous, expensive, or time consuming experiments (Hofstein & Lunetta, 2004). Different perspectives are valid in literature based on the effects of three type laboratories (hands-on, virtual and remote), however, there is no consensus for the efficient and appropriate use of these laboratories (Nickerson et. al., 2007; Aufschnaiter & Aufschnaiter, 2007). For example, Brewer et al. (2013) support the use of hands-on laboratories in science teaching because the primary rationale for hands-on laboratories is to provide the real interaction between the student, chemical instrument and instructors. However, in literature combining the types of laboratory practices are provided. Mixing the three-laboratory experience type could cause different design principles and understandings for science education (Ma & Nickerson, 2006; Abdulwahed & Nagy, 2009).

Another alternative of simulations and remote laboratories, videos have be used in educational settings as a form of OERs through many years. The demonstrations, videos and podcasts were provided to support the laboratory instruction for many years, which could be used as pre-lab lecture overview or in-class presentation (Powell & Mason, 2013). These videos can be used as a form of recorded lecture or as a form of step-by-step instruction, which shows how to apply a procedure. Related with the videos as the popular way of distribution, podcasting, it could be used in three ways in educational setting as substitutional (recording the whole lecture to access any time), supplementary (summary of the lecture videos or additional information videos) and creative (student generated videos) (McGarr, 2009). In addition to videos, other instructional resources were used in science educational settings. For example, through ChemWiki project, the chemistry textbooks were transformed into online resources (Allen et. al., 2015).

In recent years, different alternatives are emerged for the university laboratory education in terms of pre- and post-laboratory experiences (text based or computer mediated), videos, films, and computer simulations (Reid & Shah, 2007). While pre-lab activity provides a way to preparation for the laboratory experience, post-lab activities support the interpretation and reflection process of the students (Domin, 2007). Deacon and Hajek (2010) criticized that the preparation of the laboratory courses should be especially focused on in order to increase the understanding of learning activity so that the reading the instruction sheets is not sufficient way to prepare the lesson. Similarly, Johnstone and Al-Shualili (2001) emphasize the importance of pre-laboratory work in order to prepare the students for laboratory courses. Related with the pre-laboratory exercises, different approaches were applied, which generally comprise conceptual information in text-based materials, demonstrations and questions that could be supported by electronic resources (Reid & Shah, 2007; Nadelson, Scaggs, Sheffield & McDougal, 2015). Some of these resources are provided under copyright issues, most of them is created as a form of OERs including lecture notes, syllabus, videos and simulations. As the OER studies showed that users were benefitted from many OER types but the prominent ones were videos (Hu et. al., 2015; McKerlich, Ives & McGreal, 2013), open textbooks, lectures and images respectively (de los Arcos et. al., 2015) which could be more attractive and engaging than traditional textbooks for students (Pierce, 2016). In laboratory courses, this reference is also explicit for laboratory courses that most prominent OERs in laboratory courses were videos, simulations, virtual laboratories, lecture notes etc. OERs related with chemistry concepts and experiments were provided under some OCW websites and different platforms. Some of them were provided below.

ChemCollective: Launched by some professors in Carniage Mellon Univesity, which comprise many simulations, virtual labs and demonstrations about chemistry concepts and experiments.

Merlot Simulation Collection: Launched by California State University Center for Distributed Learning, which provided peer-reviewed discussion platforms for different simulations and virtual labs.

Phet Interactive Simulations: Launched by University of Colorado Boulder provided many chemistry related virtual labs and simulations offering different language opportunities.

The OpenScienceLaboratory: Launched by The Open University provided many remote laboratories, virtual experiments and instruments, field investigations and data collection opportunities related with experiments.

In addition to these platforms, many different websites and practices are valid as virtual chemistry labs (General Chemistry Interactive Simulations, ChemReax, ChemVlab+ etc.), visual and text-based course resources (MIT OCW, UCI Open, Khan Academy, ITunes U, Curriki, Saylor Foundation etc.), open texbooks (OpenStax CNX-Chemistry, ChemWiki, Chemical Principles 3rd Edition, Boundless-Chemistry, ACS resources) and Chemistry MOOCs. Chemistry MOOC was firstly launched in 2012 in edX and 2013 in Coursera (Leontyev & Baranov, 2013).

These resources were mostly used as supportive for formal education at preparation process for laboratories. Related with the advancements and benefits of pre-lab activities supported by the use of online resources, some studies also pointed criticisms about the long procedure, and extra assessment problems (Reid & Shah, 2007). Associated with the pre-lab activities, new form of providing instruction was evolved as flipped classroom. Flipped classroom approach began to be applied in educational settings and also the general chemistry courses (Reid, 2016). Within the technological advancements, the course materials were distributed outside of the class to increase in-class discussions and learning exercises (Weaver & Sturtevant, 2015). In these cases, most of the studies implemented this method through pre-class (activities and assessments generally provided by videos and lecture notes), in-class (learning activities through discussion) and post-class (assignments) (Mooring, Mitchell, Burrows, 2016**)**. In line with pre-lab activities, post-lab activities are also important to transform the practice into new situations and to assess the process of the students' experimentation process (Reid & Shah, 2007), which could also be designed within technological resources.

In the case of METU OCW chemistry course, virtual and hands-on laboratories are provided for the basic chemistry courses. In this course, virtual environment has a supportive role for the real laboratory environment that the resources are provided without a requirement (free of charge and non-credit). Students have the flexibility to benefit from these resources so that this OCW environment provide a chance for the integration of informal learning to formal learning environment and also the practices within combination of both virtual and hands-on laboratory environments.

2.3 Impact of OERs on Teaching and Learning Activities

The impacts of OERs on teaching and learning practices is still developing area for research, some studies explored the effects of usage. Form the learners' perspective, the effects on learning activities were especially seen non-grade aspects of learning experience on satisfaction, and increased interest on subject (de los Arcos et. al., 2015), and increased confidence (de los Arcos et. al., 2014). The educators also evaluated the OERs effects on learners' activities that especially non-grade effects as improvements on self-reliance and interest on the subjects were more salient than grade effects (Weller, de los Arcos, Farrow, Pitt & McAndrew, 2015; de los Arcos, Farrow & McAndrew, 2016) and self-directed learners (Elf et. al., 2015). Form the teaching perspective, the effects of OERs on teaching were mainly mentioned to broaden the content knowledge, teaching methods, reflect on the way to teach (de los Arcos et. al., 2015; de los Arcos, Farrow & McAndrew, 2016), made easier the teaching process, increase in self-confidence and resulted in change in teaching approaches (Pitt, 2015).

As a form of OERs, textbook adoption is one of the leading research areas regarding measuring the impact of OERs on students' performance, learning and cost. Regarding the study of Allen et.al. (2015), the online version of the textbooks could be used as an alternative for traditional ones but they did not resulted in increased student learning outcome. Similarly, some studies claimed that open textbooks provided cost savings but not a change on students' academic achievement (Wiley, Hilton, Ellington and Hall, 2012; Fischer, Hilton III, Robinson & Wiley, 2015). Another study also provided consistent results that the open textbook adoption the cost benefit and better prepared students were valid, the textbooks did not changed the students' use of any kind of textbooks (Bliss, Robinson, Hilton & Wiley, 2013).

While not many studies linked the open educational resources with chemistry laboratory courses, different types of open educational resources were used like videos and simulations over years. OERs were used by chemistry lecturers as supplementary, which gave advantage for presentation and demonstration of experiments or online courses and for homework but not the use of web 2.0 tools for sharing and communication (Feldman-Maggor, Rom & Tuvi-Arad, 2016). Online pre-lab resources provided many benefits for students as flexible studying time and exercise, better preparation for laboratory activities and feedback opportunities (Chittleborough, Mocerino & Treagust, 2007). As a form of online pre-lab resource, videos were found affective tools for pre-laboratory instruction (Burewicz & Miranowicz, 2006; Jolley, Wilson, Kelso, O'Brien & Mason, 2016) with balancing the quality and the length of the videos (Long, Logan & Waugh, 2016). Studies related with videos used in laboratory courses highlighted positive results that the students who watched instructor-made videos showed positive attitudes to understand the subject better, and to show better performance on assessments. In addition, the benefits of videos used in science context were provided as self-learning experience, which helped to study at own place and pace (Richards-Babb, Curtis, Smith & Xu, 2014) and as supportive to traditional education (Bos, Groeneveld, Bruggen & Brand-Gruwel, 2016). Correspondingly, podcasts could be used in line with traditional lectures to enable more time for hands-on practices and visualization in class time (O'Bannon, Lubke, Beard & Britt, 2011), to provide positive affective attitudes (Dupagne, Millette & Grinfender, 2009), and to improve self-pace of learning (Chester, Buntine, Hammond & Atkinson, 2011). However, some studies also showed contradictory results for the benefits of lecture videos about the replacement of traditional lectures and learning (Evans, 2014; McKinney, Dyck & Luber, 2009).

Another common form of OERs, simulations and virtual laboratories, some studies proved that the simulations had positive affects on students' motivation and attitudes towards chemistry (Tuysuz, 2010), also could help to promote learning in appropriate design situations (Finkelstein et. al., 2005). Other studies also showed positive outcomes by using virtual labs or simulations in comprehension of techniques and concepts (Martinez-Jimenez, Pontes-Pedrajas, Polo & Climent-Bellido, 2003), better understanding when simulations used in combination with traditional laboratories (Woodfield et. al., 2004), increased engagement with the subject and effective laboratory support (Tsekleves, Aggoun & Cosmas, 2013). Correspondingly, according to the study of Gryczka, Klementowicz, Montclare, Sharrock and Maxfield (2016), the students were provided a summary of key topics in written format, questions related with these key knowledge and simulation, which enable to implement the experimental procedure. Based on the results of this study, the students performed better in post-assessments and showed an increased interest and preparation for the course.

2.4 System Theory as Research Framework

Banathy (1992) defined the system as "a configuration of parts or components connected and joined together on a web of relationships" (p. 10). He classifies the systems in two components natural and designed systems. Designed systems were divided into three groups as designed physical, designed conceptual and human activity systems. Human activity systems, which the course in this case is a type of, are designed systems operated by individuals to achieve a purpose (Banathy, 1992). Banathy proposes three models to have an understanding and description of complex systems as systems environment model, functions/structure model and process model, which each of them provides a comprehensive picture for educational systems (Banathy & Jenlink, 2004).

2.4.1 System-Environment Model

Banathy (1992) defines this first model to display of “birds-eye-view” of the system environment, which helps to examine the boundary of the system within the suprasystems and subsystems. This lens simply asks the question of *what is the system of interest* (Walton, 2004) and entails the interrelationships, interactions and relations and regulations of the system in the systemic environment (Banathy, 1988). In order to portray the systemic environment, some tasks were defined to describe and analyze the system-environment model.

Embeddeddnes of the system: The first purpose in this model is to define the boundaries of the system of interest and to provide the insiders and outsiders of the system.

System of interest: the second purpose is to define the system of interest, which makes the system of interest different from the factors and features in the systemic environments (Walton, 2004)

System boundary: The third purpose is to define the boundary of the system of interest. Definition of suprasystem, subsystem and system’s space brings into focus the importance of system boundaries. The system of interest has a space identified by the boundaries. These boundaries could be differentiated by geopolitical, physical, economic, social, sociobiological, psychological, cultural ethical etc. (Banathy, 1992). These diverse kinds of boundaries could be found in open system types.

Self-regulation of the system: Self-regulation means how the system makes the adjustments between the inputs and outputs. Within the boundaries of the system of interest, there are some breaks that system get inputs and give outputs to the environment. In the systemic environment, the inputs and outputs are the most relevant and effective factors that affect the system of interest. Both inputs and outputs are three types, which called *definition*, r*esources* and *undefined*. Inputs refer to every factor that the system gets from its environment. First type of input (definition) constitutes the expectations, demands, policies and requirements expected from the environment. The second type (resources) refers to the different resources the system requires to develop the functions of the system. The last type (undefined) called noise, which deal with unexpected inputs from the environment. Outputs are the kind of results that the system gives its environment. They similarly have the same types with inputs. Through these types (definition, resources and undefined), the expected outcomes (products, policies, services, resources etc.) of the inputs are identified.

2.4.2 Function-Structure Model

As the second model, function/ structure model helps to portray the purposes and functions of the system of interest at the given time (Banathy, 1992). This model simply asks the question of what the system does at specific time (Walton, 2004). Through this model, different tasks are provided to describe the functions and structures of the system make.

Image of the system: The first step of describing the system of interest (case) begins with defining the image of the system. Image of the system aims to provide initial answers for what the system is about and what system type it is (Banathy, 1992). It is also supported by two sources as society and expectations of the system; and people in the system and their expectations about it.

Core definition: Core definition of the system entails two components as statement of purposes and system specifications. First, statement of purposes includes providing generic and specific purposes of the system does. The generic purposes provides an understanding of what system does for systemic environment and system of interest, the specific purposes provides more detailed understanding for the specific purposes of the system differentiated from other systems (Banathy, 1992). Second, system specifications provide an understanding for defining the functions of the system. These specifications include the clients and owners of the system (who is inside the system and their tasks), system's responsibility to its environment and environmental constraints (what are the limitations or constrains that the system faces)

Functions and structure of the system: The third step is related with the functions of the system, which refers to the primary operations that portray the system in order to implement the purposes of the system (Banathy, 1992). Function was defined as "a set of high-level, core, repetitive activities that the system performs to pursue the purposes" (Walton, 2004, p. 277). In order to carry out functions, the system has different components inside the system. The relationship between these components, which provides the structure of the system, constitutes the functions of the system.

2.4.3 Process Model

The systems need a transformation process between inputs and outputs. This transformation is called *process*, which defines what the system does through time and how the system does it (Banathy, 1988; Walton, 2004). The process within the system includes four steps in terms of input processing, transformation, output processing and system guidance/management process.

Input processing: This process includes four components as interaction (process) of the system and its environment, identification (process) of the relevance of the input for the system, introduction of the inputs for transformation process and guidance/management for the adjustment of the three processes above.

Transformation process: This process acts as a bridge between input and output processing which displays the transformation of inputs to outputs. This process entails three steps as transformation production (key entity for transformation), transformation facilitation (energizing the components for transformation) and guidance/management (making available of all the entities for the transformation process).

Output processing: This process includes three components as dispatch of output (identification of relevant and adequate output), facilitation (energizing the components for output processing) and guidance/management (making adjustment of the two processes above).

Guidance/Management (Feedback/Adjustment/Change): This process works for the management and adjustments for the feedbacks of the system. Two components are valid through this process as feedback/adjustment and system change. Feedback/adjustment involves collecting evidence for the adequacy of outputs, analyzing these outputs and constructing a model of adjustments and introducing these adjustments (Banathy, 1992). Beside feedbacks of the system produces, the outcome model of the system could change if the actual model does not represent the system anymore.

2.5 Implications of Literature Review

As seen in the background of the study and literature review sections, limited studies are valid in the use and adoption/integration and impact studies related with the OERs. First, while there are many studies related with the use of OERs through formal and informal learners' perspective, these studies are mostly showing demographic data for the usage patterns and behaviors. Moreover, there are limited studies, which shows the users' motives and barriers of using these kind of resources throughout a longitudinal study.

Second, for integration and adoption studies, there are many studies on how to adopt and integrate the OERs into educational contexts through some social, financial and personal issues; the studies, which focuses on the current use and integration of OERs after the adoption practices, are scarce in the literature. Moreover, there is a lack of literature related with analyzing the educational practices through systemic perspective, which could enable the researchers to evaluate the OER practices from a holistic perspective.

Third, most of the impact studies are mainly focused on the textbook adoption studies and many of them provides quantitative data to evaluate the impact of OERs on user's teaching and learning activities. Correspondingly, there is a limited literature on qualitative or longitudinal studies, which could provide much detailed understanding for the impact of OERs on teaching and learning activities. Therefore, regarding the studies in the literature, this study could provide an enlightenment for the gap the literature.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This study seeks to understand the contributing factors for using OER in science lab courses and to analyze the foundational elements for integrating OER into science lab contexts. This section explains the research methodology and the procedures in terms of research questions, research method, and research design, theoretical orientation research participants, data collection, data analysis and quality of data.

3.2 Research Questions

This study will investigate the following main research and sub research questions:

3) Which factors influence adoption of OERs into science laboratories?
    a. Which factors represent the usage behaviors of OERs through the lens of preparedness for the general chemistry laboratory course?
    b. What do lab assistants and students experience during the implementation of general chemistry lab courses, which could possibly be related with the implementation of OERs?
    c. How do policy practices promote the use and integration of the OERs into the general chemistry laboratory environment?
4) How does the utilization of resources facilitate the students and research assistants' perceived performances through the chemistry laboratory course?

3.3 Methodology

3.3.1 Research Method

Research is a way of constituting a new knowledge by investigating and understanding phenomena. Educational research covers three types of designs in terms of qualitative, quantitative and mixed methods (Creswell, 2009). Creswell (2009) defines the qualitative method as a way of analyzing research problem by exploring the phenomenon and variables. In addition, Yin (2011) defines the characteristics of qualitative studies as “examining the real-life context, perspectives of the participants, covering contextual conditions which people’s lives take place, contributing insights into existing or emerging concepts, striving to use multiple sources of evidence” (p. 8). Therefore, in this study, qualitative research method is preferred to have a detailed perspective for the use of OER in science lab courses through the experiences of students, teaching assistants and faculty members.

As a qualitative inquiry, this study was designed as naturalistic inquiry rather than the experimental approach, which enable the researcher to observe the actual condition of the experiences and outcomes by minimizing the control of the researcher on the variables (Patton, 1990). In addition, while experimental design mainly shows the causal connections instead of explaining why and how questions in detailed (Miles & Huberman, 1994); case study was followed rather than experimental design to explain the underlying issues for using OERs in detailed. Through case study perspective, holistic approach was followed to explore the case as a whole. The holistic approach, which is coherent with the qualitative inductive inquiry, enable the researcher to get multiple data from the components of the case to portray the complete picture of the system and impacts between the variables (Patton, 1990).

3.3.2 Case Study

Frankel, Wallen and Hyun (2012) stated that “the scientific research method provides us another way of obtaining information that is as accurate and reliable as we can get” (p. 4). Therefore, research method enables us to investigate a phenomenon with planned, reliable, scientific way with research methodologies. In this study, case study was selected as research methodology through the types of qualitative research. Yin (2009) defined case study as:

> "A case study is an empirical inquiry that investigates a contemporary phenomenon in depth and within its real life context, especially when the boundaries between phenomenon and context are not clearly evident" (p. 18).

Stake (1995) classifies case studies under three types in terms of intrinsic, instrumental and collective case study. In here, the researcher decided to define her case based on Stake's classification of case study, which could provide an exact explanation of her case. Based on these types, while intrinsic case defines the case as the main phenomenon of the study, instrumental case refers to the case, which helps to understand the phenomenon (Case has a supportive role here). Within the framework of the study purposes, the case in this study was defined as General Chemistry Laboratory Course (GCLC), which maintains to understand the main phenomenon (the use and integration of resources in general chemistry laboratory courses) by following instrumental case study.

Stake (1995) mentioned that the case refers to dealing with both common/similar and unique parts of that case that each case could cover two of them in many different ways. The purposeful sampling method was followed while selecting the case of the study. Purposeful sampling method is convenient when the phenomenon is analyzed in depth with representative and rich informants (Creswell, 2012; Fraenkel, Wallen & Hyun, 2012). The idea behind the purposeful sampling is to select the individuals/cases that help the researcher ideally to understand the phenomenon in qualitative research rather than selecting so many individuals/cases randomly as in quantitative research (Creswell, 2009). This case was selected by using intensity sampling as a form of purposeful sampling method, which helps to examine the cases in detailed (Patton, 1990). This case was selected because the use of the resources were explored to have a little effect on the system so that it is important to understand how the course system is operating and why the resources faced with the problems on integrating into the system. However, the researcher did not define the case as an extreme case, which uses a similar logic with the intensity sampling by selecting information-rich cases (Patton, 2002), because the main focus of this study was to examine the phenomenon through the information-rich case not an extreme case. In addition, the resources used in General Chemistry Course case was awarded as outstanding resources (by OpenCourseWare Consortium/Award for OpenCourseWare excellence & OCW People's Choice award) which could be defined as successful but not an extreme case of resulting in outstanding success or failure for the case of this study (Gall, Gall & Borg, 2007). This case was an exceptional case, which was first developed open educational resources in chemistry laboratory context in Turkey, but this might not determine the case as critical or exceptional for other institutions in the world, which pointed the common/typical features of the resources. Correspondingly, Stake (1995) stated that while selecting a case for instrumental case study, the focus is to select the cases, which possibly provide maximum understanding, patterns or even generalizations for other cases. However, Stake (1995) also pointed that the generalizability is not the primary focus, the limited time and sources may lead the researchers to select rich-information, unique or typical cases. Therefore, this case has both unique and common characteristics so that while the researcher was selecting the case, she mainly focused on the information-rich case, which could give intense knowledge about how to use and integrate these kinds of resources in chemistry laboratory courses by using intensity sampling. In addition, this case was selected because it was the first attempt in the university to provide visual OERs in practical courses (general chemistry and physics). The chemistry resources were also selected because the application of the experimentation in the content of the OERs was more observable and applicable in the classroom environment than the physics resources.

Unique characteristics of case study are defined as dealing with more variables, diverse sources of evidence and guiding theoretical background for the designing process (Yin, 2009). Similarly, Gagnon (2010) emphasized that the case study is convenient for both verifying and building a theory and also it is powerful for analyzing a unique and unsought case. Firstly, in this study, multiple data was collected through documents, interviews, and observation in order to reveal the variables throughout the study. Secondly, as a theoretical orientation, system theory was followed to examine the purpose of the study within the case in detailed. Patton (1990) defined the system study, which "asks how and why does the system as a whole function as it does?' (p. 78). System theory could be used to reveal the real-world problems as a whole within the use of qualitative inquiry. They are mostly used through holistic perspective, which indicated the system as a whole within dependent parts of itself (Patton, 1990)**.** The holistic inquiry in the case study works well with the systems approach. Case study approach, which uses the components of the system (method, learning-teaching activities, instructional materials, assessment etc.) as units of analysis, also provides insights for the effect of the resources into the system based on the experiences of the participants (Patton, 1990). Therefore, Systems Theory was used about how the course is operated within its components. This operation could provide an insight for the relationship of these components with one of them (instructional materials) and how the resources were used and adopted in the system.

Case can refer to an individual, organization, institution, implementation process, system or programs (Gillham, 2000; Merriam, 2009; Simons, 2009; Yin, 2009). However, this case should be bounded with the particular lines, which characterize what will be studied through the case (Merriam, 2009). These particular lines define the particular unit of analysis (case components), particular data collection methods and time, and particular limits for the participants of the study so that these definitions clarify the uniqueness and the specific features of the case study (Merriam, 2009). Related with this characteristic of the case study, this study was designed by following the characteristics of the case study. The purpose of this study is to provide a detailed picture of the use and integration of the resources, which was, classified a type of OERs through the course system. Specifically, this study especially aims to enlighten the usage profile of the students; experiences of the students, faculty members and lab assistants within the use of OERs; the policy practices which could affect the support for the use of the OERs and the performance outcomes of using them, and faculty members and the lab assistants' suggestions for the integration of the resources into lab science courses. Related with these purposes, the bounded system in this study was identified by the characteristics of the participants (students, teachers and lab assistants), particular data collection methods (observation, interviews, and documents) and the particular limits of the number of the participants (only the freshmen students that use resources in General Chemistry lab course). Therefore, this study will enlighten the purpose that was not emphasized before and also, this case will help to understand the use and integration of the resources in Chemistry lab course in Middle East Technical University which constitutes unique and also a common case regarding both the case and the phenomenon.

3.3.2.1 General Chemistry Laboratory Course Case (GCLC)

3.3.2.1.1 Description of the Setting

GCLC is carried out in a laboratory in the ground floor. This laboratory is used only for General Chemistry course so that the materials and equipment are designed for this course. As seen in the Figure 3.1 & 3.2, the laboratory includes fourteen benches, which are surrounded by equipment above, and some other equipment and materials are placed in left and right side of the laboratory. There are six blackboards which teaching process was carried out by teaching assistants.

Figure 3.1 Picture from the classroom setting

Figure 3.2 Picture from the classroom setting

3.3.2.1.2 Description of the Course

GCLC is a must course for freshmen students at university for majors (students in chemistry departments) and especially for non-majors (students in several departments). Among non-majors, this course is offered for one semester for some departments (CHEM 107 - EE, CE, IE, FDE, ENVE, CENG, AEE, ME), on the other hand, some departments take the course throughout two semesters (CHEM 111/112 - GEOE, METE, MINE, PETE and CHE & CHEM 101/102 - BIO, PHYS and PHED) (Table 1). For this study, two groups were selected from CHEM 111/112 section groups. As selected participants, CHEM 111/112 main lecture includes the topics of the metric system, introduction to stoichiometry, the structural and physical properties of matter, i.e., electronic structure of atoms, chemical bonding, molecular geometry, hybridization and molecular orbital and the states of matter, i.e., gases, liquids and solids (CHEM 111 / Fall Semester), and discussion of physical properties of solutions in aqueous solution, chemical kinetics, chemical equilibrium, chemical thermodynamics and electrochemistry (CHEM 112 / Spring Semester).

For the general chemistry laboratory course, six experiments for each semester are conducted. The experiments are offered for two groups (101/102 and 111/112), which comprise the same experiments throughout two-semester period. The students come to the course in two weeks period for approximately 3-3.5 hours of class time (2-2.5 hours of teaching and experimentation process and 1 hour for writing the reports). In class time, first students gather in front of the laboratory (which laboratory begins exact time on the schedule). Before enter the laboratory, they should have to wear their laboratory coat, and glasses. In addition, some clothing rules are also applied and checked by teaching assistants before entering the laboratory. After entering the laboratory, they leave their belongings to the place on the left side of the laboratory; they can only take their laboratory book to their benches. Only at the beginning of the first week, the head of the teaching assistants come to class to give brief information about the course and some safety rules for about 10 minutes. After this part, each teaching assistant takes his/her group in front of each blackboard (Generally, each assistant has his/her blackboard and responsible group of students, some changes could be applied between them also). Generally, the assistant is responsible for his/her group of students during the classroom but they could also help other students.

Before the teaching process begins, the students are required to answer pre-quiz questions, which have 4 questions and 5 minutes to complete. After the time is up, assistants collect the quizzes and the teaching process begins. During the teaching process, teaching assistants mostly used the blackboard to explain the theoretical background of the experiments; some of them explain the process of experiments by drawing on the blackboard and some of them writing the reactions while explaining the experiment. Each of them has his/her own teaching style and sequence of expressing knowledge but this process took approximately 10-15 minutes to complete. After teaching process, the students begin to maintain the experiments. They firstly need to take the required materials, which are placed in front of the blackboard on the right side of the laboratory. If they need any chemicals or equipment, they need to take them form the tables in two sides of the laboratory. While doing the experiment, they are only allowed to follow the procedure from laboratory book. They can ask the questions to the assistants or peers, but they are not allowed to use mobile phones during the course. They also use the laboratory book to calculate the reactions, fill the questions related with the experiments, take some notes and write the reports at the end of the course. After the experimentation process, if the students find the correct results for the experiments and when the assistants checks the results, they could leave the class to write their reports after they clean their benches and leave the equipment in the required places. Because, the students are working cooperatively, group members take the same results and leave the classroom at the same time. After the experimentation process, the students mostly have 1-1.5 hours to write their reports outside of the classroom. They mainly use the common place used as also a canteen inside the building at the same ground floor, they write their reports with their group members and also their peers. Even if they perform the experiments with their group members, these reports should be completed and provided as individual. After they finish their reports, they need to put them into the cans in front of the classrooms.

3.3.2.1.3 Description of the Course Materials

As mentioned in the section above, the laboratory book is the main instructional material offered officially in this course. While the students are only allowed to bring the book to the classroom and write their reports on the papers of the book, this material constitutes the main construct of this course. However, 6 years ago, two materials (which called resources from now on) were developed for this course. The resources were created for CHEM101/102, CHEM107/283, CHEM111/112 laboratory course contents. These courses' materials, equipment and the laboratory teaching process was recorded and prepared as video format (Figure 3.3), and also interactive simulation format (Figure 3.4) (in Adobe Flash format) through 2011-2012 academic year so that students have a chance to watch the real laboratory experiment and also carry out the experiment through an interactive environment by themselves (These resources could be seen through the link: http://ocw.metu.edu.tr/course/view.php?id=99)

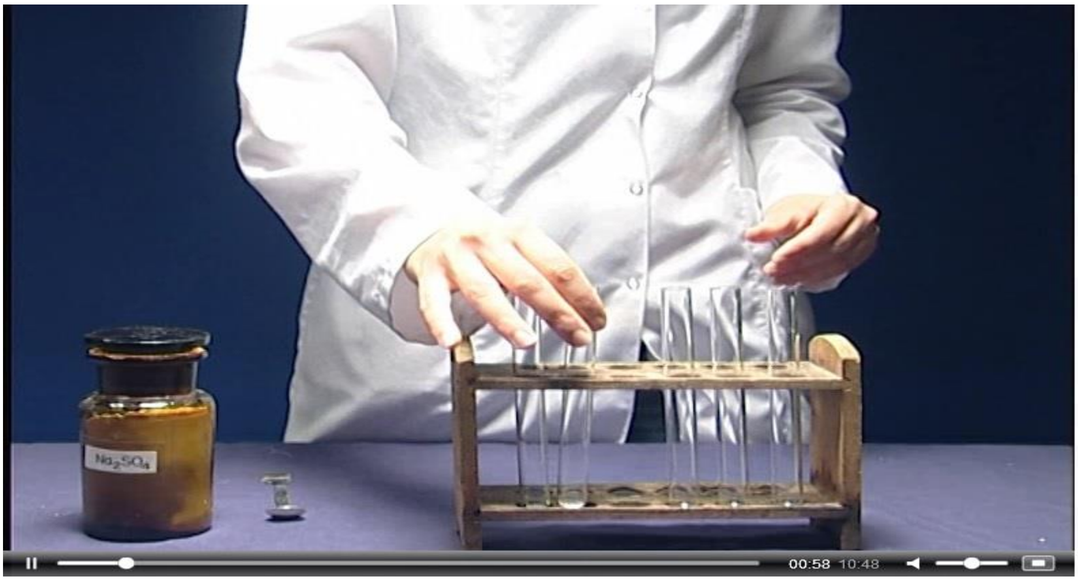

Figure 3.3 A screenshot of recorded chemistry laboratory experiments

In videos, the chemicals and apparatus, which will be used through the experiments, are shown and explained briefly. After this explanation, the procedure is provided based on the steps explained in the laboratory book respectively. As seen in Figure 3, while one of the teaching assistants are applying the procedure, the processes are verbally described by a narrator. Besides the information about the process, the theoretical knowledge is not mainly mentioned .The videos take approximately 5 to 10 minutes to watch and no questions or evaluations are required after watching the experiments.

In simulations, similar with videos, the chemicals and apparatus are provided at the beginning. However, different from the videos, the procedure requires the users to apply the procedure by themselves. As seen in Figure 4, each process were divided into steps that the users need to determine how to complete the steps. In here, when users make the wrong application, the system provides feedback to correct the application (This feedback only gives information about the choice is wrong to apply). The users cannot move without completing each step correctly. In some parts of the simulation, the users get some feedback from the system to think about the process they have but this is not very common strategy for all simulations in this system. The users also track their progress and application time through the bar on the top of the interface. Similar with videos, simulations do not contain theoretical information about the experiments rather helps the users to apply the procedure by themselves.

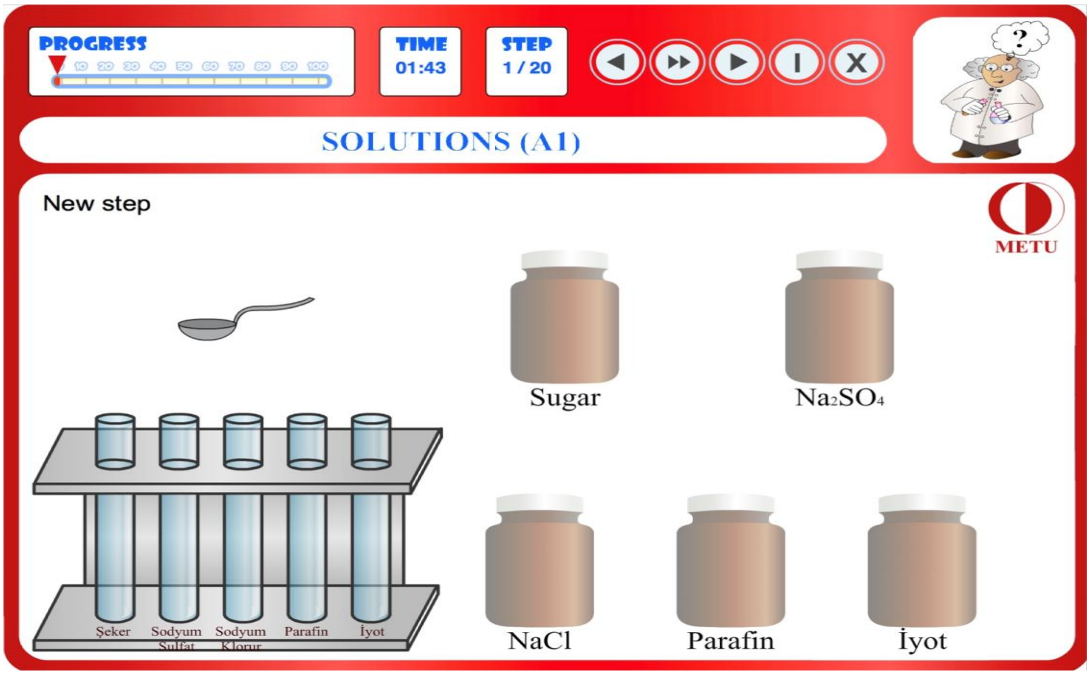

Figure 3.4 A screenshot of interactive virtual laboratory experiment

3.4 Theoretical Orientation

For this study, the system theory was followed as theoretical orientation to display and examine the complete picture of the case, which helped to understand the phenomenon of this study. While the literature helped the researcher built the research questions about the use and integration of the resources in the course, the system theory provided a ground to examine the research questions through a holistic perspective. This perspective also helped the researcher to define and explain the case and components in detailed. As mentioned in the literature review part, Banathy (1992) proposes three models for describing and analyzing the systems through three lenses as system-environment, function-structure and process models. Therefore, in the following section, how the GCLC was bounded, interacted and operated through three models by Banathy (1992)'s view of system theory and how these models were used to describe and analyze the GCLC were provided.

3.4.1 Systems-Environment Model

In this study, through this model, the environment and the community around the system were analyzed. General chemistry laboratory course as a system has an environmental space, boundaries and several inputs and outputs that affect the relationship of the system within its environment.

3.4.1.1 Embeddedness of System

The first purpose in this model is to define the boundaries of the system of interest and to provide the insiders and outsiders of the system. GCLC system (General Chemistry Laboratory Course) is surrounded by the suprasystem, which includes the general and systemic environment. General environment focuses on every other system and relations in an environment, while systemic environment refers to the direct relationships and effects on the system of interest. As seen in Figure 3.5, GCLC system as degree program has a part of suprasystems General Chemistry Course, Chemistry Department and Institution respectively within a hierarchical order. In GCLC environment, while General Chemistry main lecture has some direct relationship with the system, Chemistry department and institution constitutes the suprasystem of GCLC systems, which has some direct and indirect relationships in the systemic environment. In addition, the system gets some inputs and gives some outputs, which defined the relationship with the environment.

3.4.1.2 System of Interest

The system of interest in this study (GCLC) has its own suprasystem and subsystems in its environment. GCLC is offered under General Chemistry Course, which includes two components: General Chemistry Main Lecture (operated by professors) and GCLC (operated by teaching assistants). These two courses are peer systems, which have centralized relationships. While the main lecture offers the general chemistry concepts and theoretical background, GCLC is designed to apply this knowledge on practical experiments. Therefore, through this relationship, main lecture has a leading role on the course system and laboratory course has been arranged around it but the students should be successful on both components to pass the course.

Regarding the GCLC system, learning environment, instructional methods, instructional materials and curriculum form the components of GCLC system. In addition, the components of the GCLC system are also peer systems but they have egalitarian role that all components have equal central role in the system.

General Chemistry Course is a degree course and a major course for freshmen students in several departments (see the departments in participants section). As a degree course, this course is offered for both chemistry major freshmen students (Chemistry Department and Chemistry Engineering Department) and for non-major chemistry freshmen students to learn chemistry concepts and applications of these concepts within laboratory experiments. While the department has the primary role on defining the curriculum, the university committee and higher education council should respectively approve this curriculum. However, the department has a leading role on how to provide the courses within different methods and applications for students. Therefore as an educational system, this course is bounded with the department, institution and higher education council as hierarchical order.

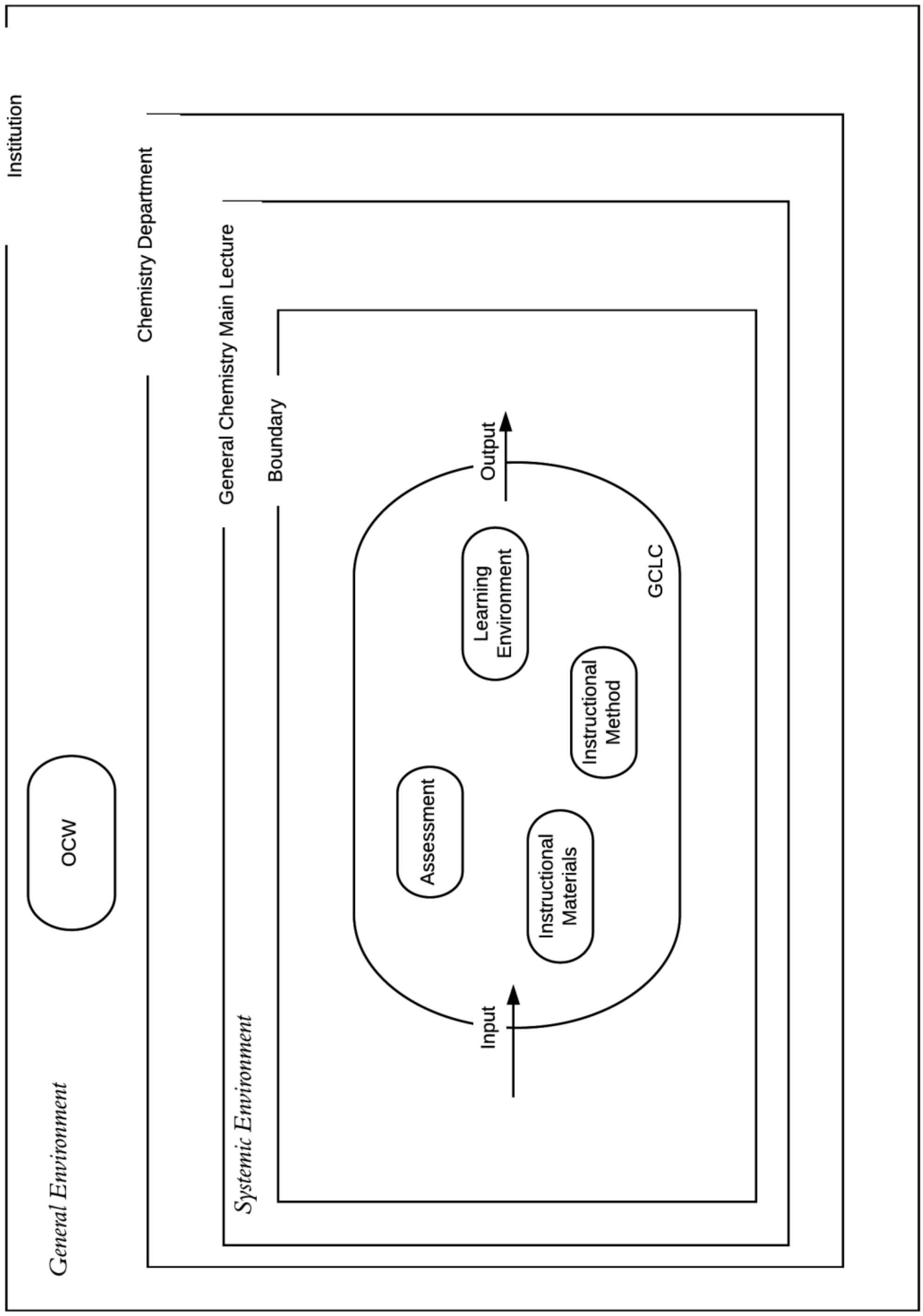

Figure 3.5 Embeddedness of the system

3.4.1.3 System Boundary

Physical, psychobiological and psychological boundaries are specified in GCLC system. First, physical boundary refers to the facilities and physical environment (or learning territory). In GCLC environment, the space is limited with the general chemistry laboratory inside the Chemistry department, which includes 12 benches, table, six blackboards and laboratory equipment. Secondly, psychobiological type shows the students' characteristics (age, educational background, department, and year). The responsible students in the system are freshmen students from several departments. The last kind of boundary is psychological boundary, which deals with the attitudes, perceptions and feelings of the students about the environment. Therefore, GCLC as a system is a part of a degree program that offers from Chemistry Department under the General Chemistry Course. It also has some components in order to meet the requirements of the system.

3.4.1.4 Self-regulation of the System

The inputs of the system were defined as people (students, teaching assistants), instructional materials, assessment, learning objectives, learning activities, teaching methods, and policy practices and expectations from the course. The inputs in GCLC system include definition and resources types. In definition type, the expectations and demands of students and instructors form the course, the impact of instructional materials on performance, the culture and attitudes toward open educational resources and policy practices are defined. As well as, the resource type is divided into two issues as people and instructional resources and facilities. People include students, teaching assistants and professors and their characteristics and experiences about the general chemistry laboratory. In addition, resource includes the instructional materials used in the system (video, interactive simulation and laboratory book) and also the facilities in the laboratory environment.

Outputs indicate what system does within received inputs. Each output in two types shows the outcomes in the system in parallel with inputs. The outputs of the system would provide satisfaction of the course, academic achievements, learning outputs, professional development, career choices etc. On the other hand, related with the resources, in definition type, the outcomes about the attitude and satisfaction for the course, use of the instructional materials and their effects on performance, the policy practices and their effects on the use of resources and learning environment are the major outputs in system of interest. In resource type of output, the outcomes are specified as the attitudes of people towards the resources and their evaluation about the quality of the resources. Therefore, in here, we provided the inputs and outputs related with the system and specifically related with instructional materials in the system in Table 3.1 below.

Table 3.1 Inputs and outputs of the system related with the OERs

Inputs	**Outputs**
Definition	**Definition**
Purpose and requirements of the course	Satisfaction level of the course Teaching and learning activities
Students' expectations about the course	Teaching and learning activities
Instructors' expectations about the course	The academic performance of the students (grades, quizzes and reports) The performance of TAs
Motives and barriers to use resources	The performance outcomes (academic, cognitive, affective and psychomotor)
Problems in the course	Teaching and learning activities Integration of resources
Departments' policies about the resources and structure of the course	Use of the resources
Academic and user culture about OER and OCW	Use of the resources

Table 3.1 Inputs and outputs of the system related with the OERs (cont'd)

Inputs	**Outputs**
Resource	**Resource**
People	
The characteristics and interest of the students	
Instructors experience and content knowledge	
Resources	*Resources*
Accessibility and interface of the resources	The attitudes towards the resources The quality of the resources
Assessments	The academic performance of the students (grades, quizzes and reports)
The facilities in the lab environment	

3.4.2 Function-Structure Model

Through this study regarding function-structure model, three steps were followed in order to describe what system does at a specific time.

3.4.2.1 Defining the Image of the System

GCLC system is about to provide practical experiments for students in order to use equipment, observe the reactions, interpret and analyze the results of the experimentation. The system's focus is to give basic chemistry content knowledge and to have primary experimentation based on the content knowledge. As seen in Table 3.2 below, the prevailing assessment of GCLC environment (initial image) and the expected image of the system (wish image) are provided.

Table 3.2 Image of the system

Specifications	GCLC	
	Generic purpose: provide practical experiments to facilitate students' learning, skills and abilities related with General Chemistry content.	
	Specific purpose 1(*): facilitates procedural knowledge within conceptual knowledge Specific purpose 2: provides experiments to interpret, analyze and examine the knowledge Specific purpose 3: provide environment for teaching and learning activities Specific purpose 4: provides resources to have procedural/content knowledge, makes students to recognize the chemicals and equipment Specific purpose 5: Provide feedback and guidance during the learning experience Specific purpose 6: make students to perform better and pass the course. Specific purpose 7: maintain safety instructions and precautions	
	Initial image	**Wish image**
Shifts in teaching activities	Teacher-centered approach to present the content to students	Learner-centered approaches to promote the full potential of the students (discovery-based, problem-based learning)
Community development	Discriminated education from other human development and social community Education for preparing employees and citizens	Education for preparing knowledgeable and skilled community member who have all societal characteristics

Table 3..2 Image of the system (cont'd)

	Wish image	**Initial image**
Shifts in learning activities	Supporting learner only in schooling years	Supporting learners through lifelong learning and adult education
Shifts in educational approaches	Traditional education supported by teacher-centered education	Open educational approaches for supporting both lifelong and individual learning
Technological advancements	Providing printed or limited number of resources for learners	Providing online and free resources for learners

Note: (*) refers the numbers correspond to the numbers on the functions of the system in Table 3.4

3.4.2.2 Core Definition

The second step includes two components: the purposes of the system and the system specifications. While the system purposes provided within the image of the system to enhance more comprehensive picture of what system is, this part only includes the system specifications.

3.4.2.2.1 System Specifications

The second step initiates to describe the characteristics of the system of interest. In Table 3.3, some key roles (clients, owners, and practitioner), system responsibility for the environment and some constraints in the environment were offered. As Checkland and Poulter (2006) propose, the people in the system are defined through key roles because some group of people could have more than one role in the system. Clients refer to the people who are investigated within the system of interest. In GCLC system, the clients are both the students from several departments and professors and TAs in Chemistry Department. On the other hand, owners of the system who are responsible and affected by the outcomes of the system were defined as TAs, faculty members and head of the department. Thus, professors and TAs have both client and owner roles. The main owner and manager of the system are TAs who manages the classroom activities and course requirements for the system. Faculty members who give General Chemistry Main Course have an indirect effect on laboratory activities but they have an administrator role for General Chemistry course and some of them in the department as a whole. Head of the department has also an indirect role as an administrator but have some responsibilities about the management and political practices about General Chemistry Course. The practitioner is the one who is intervening the system and conducting the research about the system of interest.

Table 3.3 Specifications of the system

Clients and Services	Clients: Freshmen students from several departments; professors and TAs from Chemistry department Services: Course is provided in laboratory twice a month for each group of students
Ownership of the system	TAs: the primary owner and coordinator of the system Faculty: who are responsible to operate General Chemistry Main Lecture and Course as whole and also decision taker for General Chemistry Course Head of the department: who are the decision taker of the wider system
Systems Responsibility	To provide resources, facilities and appropriate environment for experimentation To assess students' performance and behaviors in the system To provide the practical implications with combining theory with experiments To provide safety instructions while doing the experiments To consult students while doing the experiments
Environmental Constraints	Excessive number of students Limited number of TAs Frequency of course Technological infrastructure

In line with the purposes, the responsibility of the system to the environment indicates the characteristics of the services provided. The laboratory course is offered twice a month for each group of students. The system is designed to provide resources and facilities, to provide safety, to provide theoretical content knowledge and practical experimentation, to assess students' performance and learning activities and to manage students' behaviors and give consultancy during the experiments.

There are also some environmental constraints in the systemic environment. In GCLC environment, the major constraints are related with the people in the environment.

These constraints also potentially affect the purposes and functions of the system. Excessive number of students in each group make difficult to give consultancy and assess students' behaviors and performance in the environment. TAs and the practitioner have some problems to monitor all the learning activities in the classroom. Limited number of TAs also negatively affects to guide the students in the environment and also to assess the students' performance. Frequency of the course also provides a constraint for students and TAs to establish a regular communication each other. Another constraint also diminishes the quality of the course that the quality of the equipment and the lack of technological devices restrict to apply new educational practices in the environment.

3.4.2.2.2 Functions and Structure of the System

In order to define the functions and structures of the system in this system, the primary purposes and activities of the system products were defined. In Table 3.4, the functions and activities are provided.

Table 3.4 Functions and activities of the system provided

Function	Activities
Developing the resources (OERs) (4*)	Online resources (videos and simulations) were designed by ITS unit and provided through OCW website Faculty members in coordination with some TAs created the raw content for the resources and they are videotaped by ITS unit
Provide resources to groups of people (4)	A staff is responsible for preparing the equipment and laboratory environment at the beginning of each class The laboratory book is provided for both theoretical and experimental knowledge The resources is provided through METU OCW website as optional to use
	Researcher Role At the beginning of the semester, informative brochures about the resources were distributed Informative e-mails were sent to students about the resources
Acquire and maintain teaching and learning activities (1,2,3)	TAs are responsible for 10-15 min teaching process Students works in two groups while performing the experiments
Provide support for learning experience (5)	TAs are consultants for the students while doing the experiments

Table 3.4 Functions and activities of the system provided (cont'd)

Function	Activities
Provide assessments to interpret performance and behaviors (6)	TAs are responsible for preparing the quizzes, which are applied at the beginning of the course. TAs are responsible for evaluating the quizzes, reports and students' performance through the class
Maintain safety (7)	Students are primarily responsible for their safety The safety instructions are provided through laboratory book and reminded by TAs at the beginning of the semester
Define the resource unit on a continuous basis	At the end of the semester, TAs and professors discuss the problems in the course environment

Note: (*) refers the numbers correspond to the numbers on the specific purposes of the system in Table 3.2

Beside the purposes and the functions of the system, the system has a new intervention related with the instructional resources. Normally, the course officially provides a laboratory book in order to have a content knowledge related with the course. The new materials (video and simulation) have been provided through five years. Therefore, in this study, in line with the systems purposes and functions, the effects of this intervention within the systemic environment are focused on so that the purposes of this study are defined by root definition in soft system methodology. Root definition helps to determine the problem or the purpose in the system of interest. In this study, four root definitions are implied which guided the researcher for building research questions (Checkland & Poulter, 2006):

RD1: An instructor (TAs) owned system jointly operated by the instructors and students to ensure the user profiles of instructional materials.

RD2: An instructor (TAs) owned system jointly operated by the instructors and students to see the problems in the classroom.

RD3: An instructor (TAs & Professor) owned system operated by the instructors and students to see the effects of policy practices on usage profiles of resources

RD4: An instructor (TAs) owned system jointly operated by the instructors and students to ensure the effects of instructional materials on students' performance and learning experiences

3.4.3 Process Model

Within this research, the core processes are concentrated based on the functions/structures and main activities in the system rather than the general model offered in the theory. However, the structure of the process model are followed that inputs, transformation process and outputs are respectively analyzed for each process of the system maintains. In fish diagram (Figure 3.6), the inputs display the components of the system (people, instructional materials, method, learning activities, assessment) and processes how each of the inputs are transformed into outputs of the system (learning activities, teaching activities/methods, assessments process etc.).

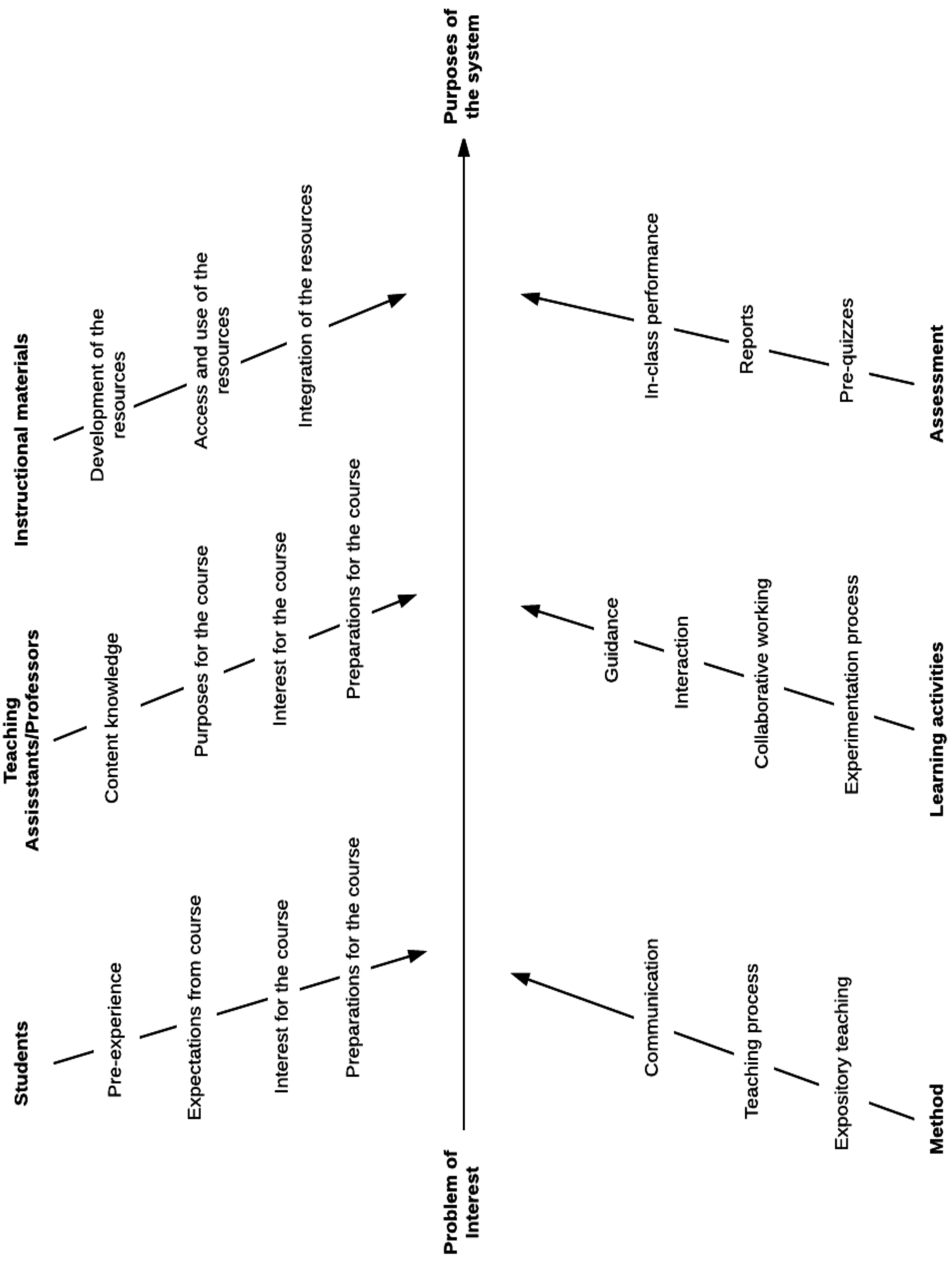

Figure 3.6 Components and process of the system

The process portrays the system as a whole but also focuses on the use and effects of instructional resources in the systemic environment. It also displays the role and place of the instructional materials in the system and the relationships between the components of the system with the instructional materials. As mentioned briefly while describing the case in the research method section, the system operates in sequence within the components of the system. As seen in Figure 3.7, each process is provided. While the main processes of system transfers were not the major purpose of this study, the process in the course and the integration of the resources in this process was mainly provided in the Adoption-Implementation section in the results of the study.

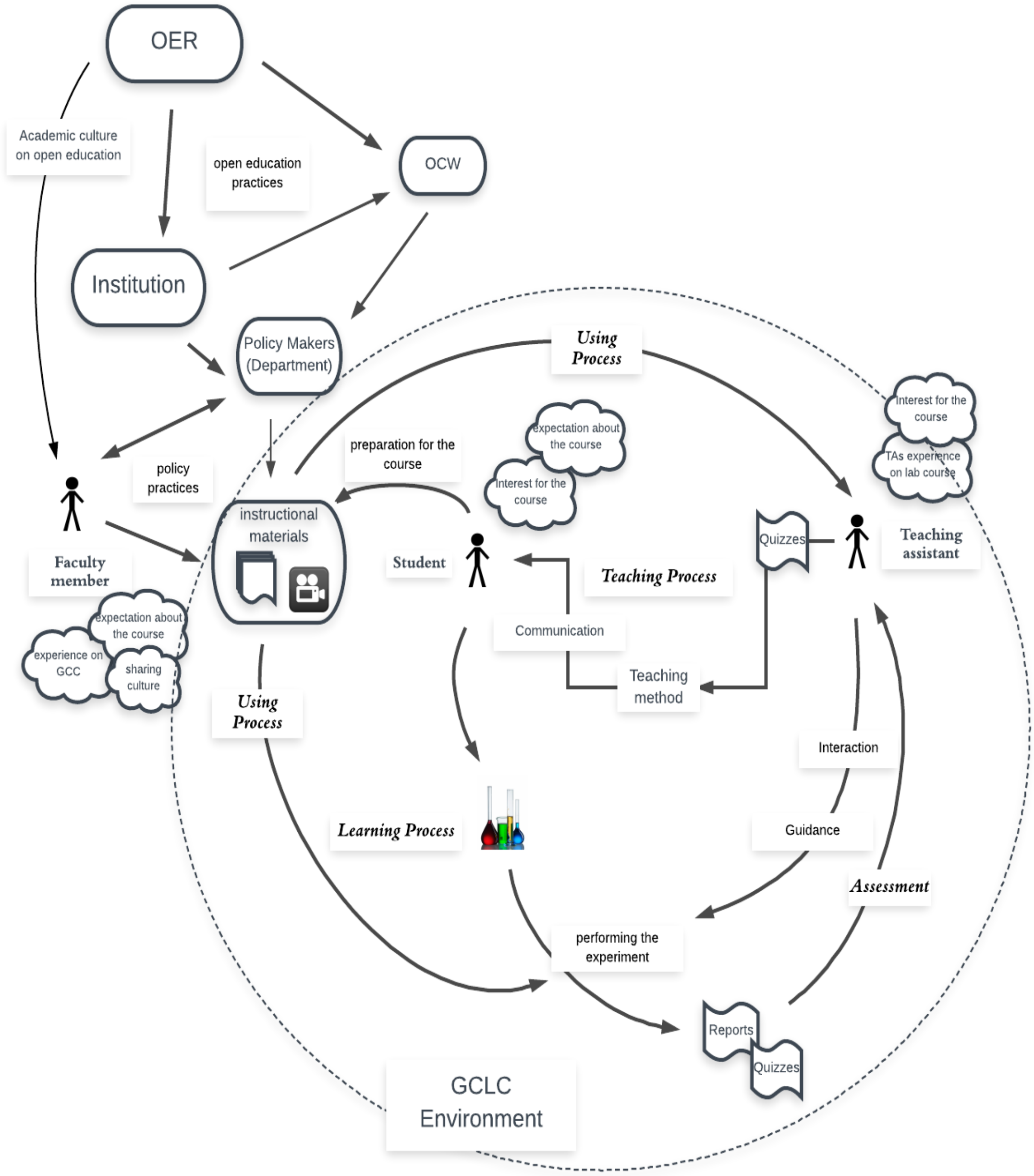

Figure 3.7 Processes of the system through the system environment

3.5 Research Design

Patton (1990) classified the inductive approach in educational research in two ways; disclosing the individual's experiences during the research and investigating the single cases (organizations, programs groups) in itself before finding their relationship with each other. Therefore, in this study, first, the case was explored in itself and then the relationship inside the case (system) was explained. Through this approach, some paths were followed through the research design and procedure. Stake (1995) classifies the research design through seven stages; anticipation, first visit, further preparation for observation, further development of conceptualization, gathering and validating data, analysis of data and providing findings. While the first five issues comprise the design and data collection processes, the last two stages cover the data analysis and interpretation processes.

For the first stage, anticipation, the researcher defined the research questions, purposes and issue for the problem of interest. Related with these issues, the case (GCLC) was defined to gather information about the problem of interest (the use of open educational resources in science laboratory setting). During the case selection, we determined how many cases to select and also defined the boundaries, possible clients and environment of the case.

For the second stage, first visit, the researcher arranged a meeting with the administrators (or professors) who were responsible for the organizational issues for the course as a whole and also with the teaching assistant who are responsible for the course activities and organizational issues. The researcher gave brief information about the research for each informant and she got permission for conducting research during the course beside the permissions from ethical committee. During this process, the researcher also discussed with the experts for which groups to select for getting information about the research and two groups were selected (see *Participants* section). In addition to that, brief information about the research and researcher was sent to teaching assistants to be familiar with the research process.

For the third process, further preparation for observation, the researcher primarily observed the classroom environment about how to conduct the observation in the classroom setting. The observation protocol was prepared based on the research questions in this study and the numbers of the participants in the classroom (see *Data Collection* section). In addition, the researcher defined her role during the observation and data collection tools to help to observe data.

For the fourth process, further development of conceptualization, the researcher developed other data collection tools such as interviews and documents to collect data. While developing these tools, some theoretical structures were followed (see *Theoretical Orientation* section). After developing the data collection tools, the researcher began to collect data in the case of the study.

For the fifth process, gather and validate data, the data was collected through two semesters within two departments (METE & MINE). Stake (1995) proposed that the qualitative researcher might observe and display what ordinarily happened in the case rather than intervening activities, processes in the case. For this study, the main purpose was to explore the actual situation and problems on the system and the resources so that the researcher tried to minimize her effect on collection data in the system. The researcher only intervene the system by communicating people and by giving some information for the resources. Regarding data collection, for the first semester, the brochures, which gives information about the resources in OCW website, were distributed to each group of students at the beginning of the first class. In this first class, the researcher also observed the environment through the activities, behaviors and classroom setting which also helped to elaborate the observation protocol for other classes. After the first class, only the information methods of resources differentiated between two groups to see whether regular information creates a difference on using the resources. For METE group, the researcher sent information about the resources (through e-mail) one day before the class for remaining five classes for only giving information about where to find the resources, however MINE group was only informed before 4th class of the first semester. Moreover, the researcher changed her strategy about the content of the e-mail that after the third class, she sent e-mails with the direct links of the resources on the website with two versions (Turkish and English) because of the students' feedbacks about "not finding the resources on the website". For MINE group, after 4th week, the researcher again did not send any e-mail to see whether the students kept using the resources. This process was changed in the second semester that while MINE group was sent information before every class, METE group was given information only before 4th class (The brochures were still distributed at the beginning of the course in the second semester). While the students were different in each semester, the researcher aimed to see the difference between the groups by cross analysis.

For each semester, the data collection methods were remaining same that the researcher observed the environment through six classes in each semester, and during this process, she defined the possible participants of the study. She made mini-talks with students during the observation, which aimed to gather data about their usage of the resources and their thoughts about them in each week. After defining the participants of the study, the students were interviewed after 5th week of class through three weeks period and all teaching assistants were interviewed after the last class. In addition, the questionnaire was conducted between first and second semester to all responsible departments for the course to define their usage behaviors of the resources. In addition to this process, the researcher attended one of the regular meetings with the teaching assistants and responsible professor who discussed the problems related with the course and the departments between two semesters. The researcher take notes form this meeting to get some information about the problems in the course and policy practices of the department. Moreover, at the end of the second semester, the researcher and her advisor arranged another meeting with the professors (includes the head of the department and professors who have some administrator roles related with the course) to discuss the policy practices and future developments about the resources. After this meeting, some professors who determined to have more information and experience for the course were selected for the interviews based on the observations in the meeting. In addition, all documents were collected at the end of the each semester.

For the last two parts, analysis and providing of data, the results of the two semester data and the groups' data were collected to define the similar patterns in the case to validate our findings rather than providing a cross case analysis (except the usage profiles of two departments based on information given). Therefore, the results of the first semester and the second semester were unified to provide a deeper understanding for this study (Figure 3.8).

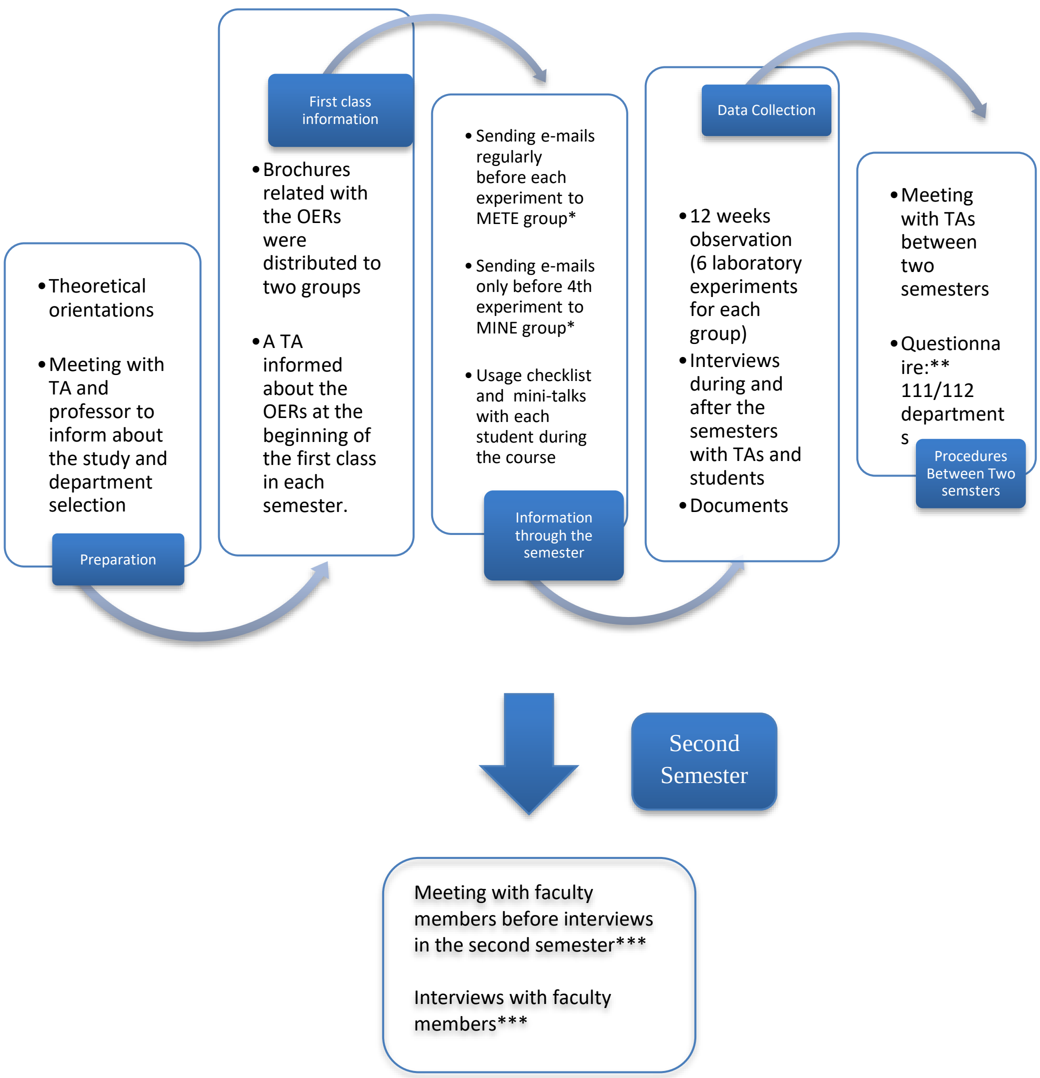

Figure 3.8 Design of the case study for the first & second semester

*This information schedule was valid for the first semester, in the second semester; the departments were interchanged by frequency of information (METE was informed one time and MINE informed regularly)

** Questionnaire was only applied between the two semesters

*** Additional procedures in the second semester

3.6 Research Participants

After defining the case of the study, we aimed to determine the target population of the study. Different sampling techniques would be focused on throughout this study. In the first phase, the demographic information of the students and their usability conditions of OER were identified. In Middle East Technical University, freshman students in several departments, which were listed in Table 6, are responsible for the general chemistry course. These departments were divided into three sections based on their disciplines in terms of CHEM107 and CHEM283 courses; CHEM101/102 and CHEM111/112 courses. These students constitute the accessible population in this study. Two different groups were selected for qualitative and quantitative data.

First, for the questionnaire conducted between two semesters, purposeful sampling was used to select all the departments that are responsible for 111/112 course. This course was selected to collect data with questionnaire because the two departments selected for the qualitative part were part of 111/112 courses. Therefore, six departments (Table 3.6) completed the questionnaire and 303 responses were defined as usable for the analysis.

Second, for the qualitative data, two departments were selected. In order to select them, typical sampling as a form of purposeful sampling was used to select the groups with similar characteristic and membership which both showed average or typical characteristics (Creswell, 2008; Patton, 2002). In here, we used typical sampling because it was aimed to discover the phenomenon in depth and within the typical samples, we could generate some knowledge of the phenomenon we searched. Before selecting the groups (or departments), some expert views were gathered to identify the similar groups in terms of their discipline, performance in the course, sections and their university exam score. In addition, the groups should not be extreme cases for not to affect the inferences from the research. Based on two expert reviews from Chemistry Department, Metallurgical and Materials Engineering (METE) and Mining Engineering (MINE) Departments were selected as target groups of this study. In here, non-major chemistry students were especially selected because of eliminating the bias of willingly uses of the resources. Based on the major chemistry students' interest or content knowledge, they could willingly use the resources. Therefore, two non-major departments were selected for this study. They were defined to have both similar past performances in GCLC and they were both performing same experiments (section CHEM 111/112). At the same time, while the students in METE department had generally higher university exam score than the students in MINE department, this was not determined a huge discrepancy by the experts based on their performance in the course in the data collection period. Experts defined the university entrance exam score as a significant characteristic for students' overall performance in GCLC that higher exam scores created higher performance in the course. However, it is also important to note that the discrepancy between the performances for this course was especially defined between the extreme groups like Mechanical Engineering and Petroleum & Natural Gas Engineering. While there were many factors, which could affect the performance differences between the groups in the system, these scores seemed to have an affect on defining the group performances. Therefore, METE and MINE groups were selected by having similar characteristics and average performances in the course, which could provide valuable information about the phenomenon of the study. While the aim of the study was to get in depth information from the groups rather that comparing different groups of performances, typical sampling method was seemed to fit well for the purpose of this study.

Table 3.5 Courses and responsible departments offered General Chemistry Laboratory Experiments through OCW

Departments	Responsible Students	Course Details
CHEM101	BIO, BIOED, PHYS and PHED students	GENERAL CHEMISTRY I (Fall Semester)
CHEM 102	BIO, PHYS and PHED students	GENERAL CHEMISTRY II (Spring Semester)
CHEM107	EE, CE, IE, FDE, ENVE, CENG, AEE, ME students	GENERAL CHEMISTRY (Fall and Spring Semesters)

Table 3.6 Courses and responsible departments offered General Chemistry Laboratory Experiments through OCW (cont'd)

Departments	Responsible Students	Course Details
CHEM111	GEOE, METE, MINE, PETE, GENE and CHE students	GENERAL CHEMISTRY I (Fall Semester)
CHEM112	GEOE, METE, MINE, PETE, GENE and CHE students	GENERAL CHEMISTRY II (Spring Semesters)
CHEM283	ELE students	GENERAL CHEMISTRY (Fall Semester)

In the second phase, the participants of the study were determined through the study. The target participants of this study were students, faculty members and teaching assistants (Denomination of the participants were provided in Table 3.7).

Table 3.6 Denomination across group of participants

Denomination of the Participants	**Participant Groups**
SME #1, SME #2, … SME #19	Students / METE group
SMI #1, SMI #2, … SMI #19	Students / MINE group
TA #1, TA #2, … TA #11	Teaching assistants
P #1, P #2, P #3, P #4	Professors

Note:
For student groups, " > #9 " refers to second semester students (SME #10, SME # 15, SMI #17)
For teaching assistants, " > #6 " refers to second semester assistants (TA #7, TA #10)

While selecting the participants, maximum variation sampling, confirming, and disconfirming sampling which were also forms of purposeful sampling was followed. Maximum variation (heterogeneity) sampling is mainly used to describe the diverse features of the case (Patton, 2002). In addition, confirming and disconfirming sampling is defined convenient when the researcher select individuals after the study begin to confirm and disconfirm the preliminary or possible findings of the study (Patton, 2002; Creswell, 2012). After selecting the departments to observe in this study, the researcher did some observations and mini-talks with the students who possibly confirm or disconfirm the phenomenon but also could provide rich information for this case. During this fieldwork, until the fifth week of the observations, the researcher did some exploration for the target participants of the study. These participants were defined based on their usage patterns, behaviors in the classroom and their feedback given in the classroom during mini-talks. In each group, three students' profiles were determined as permanent users (uses the resources in each week), unstable users (uses the resources in couple of weeks) and one-time-users (uses the resources only one week). In here, while the permanent users were valuable to provide information about their sustainable usage behaviors, unstable and non-users were valuable for this study to give significant information about the drawbacks of the resources and also they could compare their performances between the weeks of use and non-use in this case. For non-users, the researcher did not select the students who never used the resources because they at least needed to know resources' environment to criticize them during the fieldwork and interviews. In addition, while selecting the participants, also the performances during the experimentation was observed and the performances of the users and non-users were defined as criterion to select the participants. In here, during the observation, some performance criteria (Appendix E) (the ability to do the experiment with or without the group member, the ability to know the chemicals and equipment, the ability to follow the steps in the experiment, the interaction with the teaching assistant/ researcher and group member, the ability to finish the experiment earlier) was followed for possible target students for this study. Moreover, in order to select information-rich participants, the researcher got some interaction with the students to get some personal information about them. During the fieldwork, the researcher could make some connections (closeness) with the environment and individuals to discover the experiences and to provide some confidence for the individuals to understand their behavior and activities (Patton, 1990). Therefore, for this case, the researcher selected the participants during the fieldwork. She used maximum variation sampling to define the several characteristics of the different profile of participants (permanent users, unstable users and one-time-users) (Gall, Gall & Borg, 2007); and used confirming and disconfirming sampling to confirm (higher usage higher performance or low usage low performance) and disconfirm the case (low usage higher performance or higher usage low performance). Beside students, teaching assistants and professors were also valuable clients in this study. For two semesters (6 teaching assistants for the first and 5 teaching assistants for the second semester), all teaching assistants who were responsible for two departments participated this study. While some of them were responsible for two groups, rest of them was responsible one of the groups in each semester (the distributions of teaching assistants to the groups were provided in Table 16, see Results section). All teaching assistants were also responsible for different department, which could also enable them to compare the groups' performances. It is also important to note that it was hard to find two groups, which shared more than two assistants at the same time so that METE and MINE groups provided significant opportunity based on having same teaching assistants in each group. Regarding professors, the researcher did not define the professors in the first semester because the professors did not have direct interaction with the laboratory course but they had valuable information about the organization and policy issues related with the system. In the second semester, the researcher determined 4 professors based on the meeting with them, which had at least five-year experience in the department and more than two-year experience at GCLC. Particularly two of them had active role on administration during the data collection time and two of them had past experiences on the administration. Therefore, for this case, the reason for selecting purposeful sampling and its types was to assume that these students, faculty members and lab assistants would provide a rich description and exploration for understanding why they use OER in their lab courses and the fundamental elements for the integration of OER into science lab courses. As summary, the process of selecting participants through two semesters was provided in Figure 3.9 below.

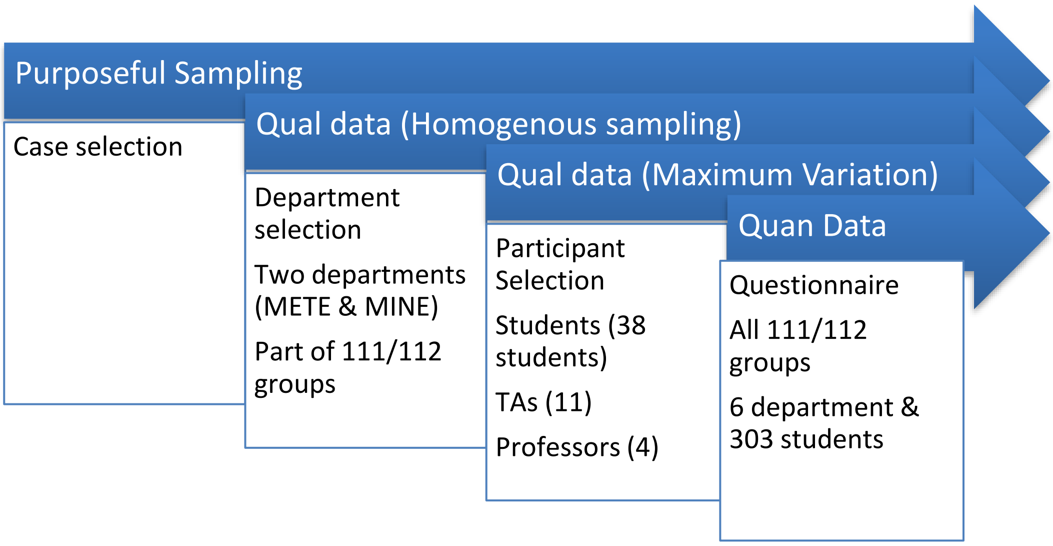

Figure 3.9 Participant selection of the study

3.7 Data Collection

For this part of the study, four data collection procedures were followed in terms of questionnaire, observation, interview and documents. The strength of case study is related with the diverse instruments in terms of documents, artifacts, interviews and observations (Yin, 2009). Therefore, data were collected through different procedures in order to get a powerful insight to support the results of this study. The process of data collection was followed by a sequence between two semesters that observation, interviews and documents were collected through two semesters and the questionnaire was collected between two semesters.

Observation

Observation was used in order to examine the activities and behaviors of students and teaching assistants and to explore the users of the resources and their experiences with them. Simons (2009) listed the benefits of the observation in terms of having a general picture of an event, rich description of an event, values and norms of the context, a chance for analyzing the experience detailed and rival data for other data sources. In this study, observations were carried out 6 times for each group (each group had six lessons includes six experiments in each semester) through each semester within nearly 2-2.5 hours of observation for each class. During the observation, the classroom was organized to portray the students and teachers' behaviors in the classroom. For this situation, the researcher had a chance to see the setting and activities that provides a rich description of the event. In addition, the researcher also made some mini-talks with the users among students to gather their experiences with the resources (approx. 5 min with each student).

The researcher had a role as observer-participant who was mainly observer but sometimes participant for getting some data and having interaction during the fieldwork (Gall, Gall & Borg, 2007). Even if the students saw the researcher as one of their teaching assistants (For example: they generally asked questions in the experimentation process) and the researcher interacted with the students, she was not an actual participant in the setting. Moreover, in order to minimize the researchers' effect on students and teachers' behaviors, the researcher mainly stood in obscure positions not to distract their attentions. In addition, at the beginning of the research, none of the groups was informed to be observed by their behaviors but only observing the environment and having information about their usage profiles of the OERs. Similarly, video recording was not used not to create artificial behaviors in the setting. As a kind of using *unobtrusive measures*, which enable the researcher to collect data from the individuals who do not recognize to being observed (Gall, Gall & Borg, 2007), this method could raise some ethical issues. However, awareness of the participants of being observed for their behaviors or activities could make them uncomfortable or stressful while conducting the research. Therefore, if any ethical risk and anonymity of the participants are supported, the unobtrusive measures could be used in some situations (Gall, Gall & Borg, 2007) so that these two issues were maintained through the data collection process. In addition, during the observation process, while asking the students' usage behaviors; they were informed during mini-talks in every week that their usage would not have any effect on neither their grade nor the researchers' perception about them in order to make them feel comfortable about the situation.

The observation was recorded by using continuous recording method, which enables the researcher for observing and recording all the events happened in the setting within an observation protocol (Gall, Gall & Borg, 2007) (Appendix E). However, while it was difficult to record every activity in the setting, the researcher mainly focused on the possible future participants' activities with the help of the criteria prepared for the observation process. These criteria to observe the participants behaviors were listed in the observation protocol provided in Appendix E. These criteria were used to discover the current classroom environment of the students. After the researcher filled the observation protocol, she added her reflective notes and some information about the environment to complete the observation protocol after each class observation. These data, which comes from the field notes, serve a supporting role for other data sources (interview, archival records and survey instrument) and particularly analyzed with the interview data to have a complete picture of the phenomenon.

Interview

For the second source of data, interviews were implemented in this study. While interviews were defined as one of the main important data collection methods for case studies (Yin, 2009); students, faculty members and lab assistants were interviewed to support the data revealed from the observations. As Gillham (2000) mentioned that there could be some discrepancies between what people say during the interviews (he claimed that they are sincere) and what they do in reality and he explained it with the quotation "they are not lying; they are just not accurate" (p. 13). Thus, in here, it was fundamental to support the interview data with the field notes from the observations. While it was difficult to observe the participants' actual performances in detailed, the observations were successful enough to give an idea about each of the participant in the environment.

The interviews with the students were held at the end of the fifth week of each semester during three weeks period for each group, which enable students to have enough experience with the resources and the system environment. Moreover, while the interviews with the teaching assistants was organized at the end of the sixth week of each semester during two weeks period, the interviews with the professors were held at the end of the second semester of data collection period. Semi-structured interview protocols for students were shaped based on the factors of causes for using OER in their general chemistry laboratory course, the effects of their performances and behaviors in the setting and their ideas about the advantages and disadvantages of using OER in general in lab courses (Appendix B). Moreover, different from the students' interview questions, interview protocol with faculty members and lab assistants was formed around their perceptions for the use of resources in their lab courses, the implementation process of the resources in their lab courses and their ideas about the effects of resources on the students' performance in science lab courses. In addition, they were also questioned mainly about the policy practices in the department and their effects on the use of resources (Appendix C & Appendix D). Before the interviews, a consent form, which gives an exact purpose of the study and requirement for conducting the interviews were provided to the participants. Interview questions were prepared to have detailed information about the essence of the study and these questions were supported with probes to get additional or elaborative information about the questions (Creswell, 2012; Merriam 2009). These probes were mainly prepared before the interviews but some of them were emerged during the interviews and added to future interview sessions. During the interviews, two ways were used to record the data: audio recordings and taking notes. Audio recordings were used to remember all the data in the interviews within the permission of the participants. In addition, the researcher also took some notes during the interviews, which pointed significant behaviors and inferences from the interviews (Creswell, 2012).

Documents

For the third source of data, documents and records were used to support the data of interviews and observations. As the form of documents, official documents, which were mainly generated by organizations, schools, institutions etc. (Bogdan & Biklen, 1998) were used in terms of laboratory book, the sample of assessments were used. While the purpose of the study was not evaluating the quality of the laboratory book and assessment technics, the interviews revealed some problems related with the quality of these documents so that the documents were explored to give information about the system. In addition, as researcher-generated documents; e-mails, brochures, photographs of the setting and notes from the meetings with the teaching assistants and professors were generated to explore the students' usage behaviors.

The researcher attended two meetings during the data collection period, first one was with in the regular meeting arranged to discuss the problems and activities in the course within teaching assistants and responsible professor between first and second semester. The second one was arranged with the professors who have experience at the course at the end of the second semester. For the former one, all teaching assistants and one professor attended the meeting and analyzed the concerns and problems in the course and defined the division of labor for future courses, which enable the researcher to understand the course environment from the teachers' perspective and some organizational issues. For the latter one, seven professors attended this meeting and provided their concerns and problems related with the resources and they mentioned another problem related with the department and other courses, which could restrain the possible developments for the resources. These data and notes of the researcher were unified with other data collected from observations and interviews.

As a form of documents, records were used in order to get information related with the access of the resources, and the performance records (grades) of the students. Records were defined as the computer files, maps, service records, and survey data, which serve quantitative data for the case study (Yin, 2009). In this study, the grades of the students, which could give an insight about their performances in the course, were gathered. In addition, OCW logs, which show the number of users of the resources in Chemistry laboratory course and other courses in the system, time spent on each of the experiments, were analyzed to have information about the usage profiles and popularity of the resources.

Questionnaire

Lastly, at the end of the first semester, a questionnaire was used in order to get information of students' access, use and perceptions related with the use of the OER in their general chemistry laboratory courses. Creswell (2009) proposed that "a survey design provides a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a sample of that population” (p. 145) so that in this study, in order to define the perceptions and demographic information of students, a questionnaire was used to collect the data. Yin (2009) indicates that in the case studies, quantitative data collection techniques could be used in the units of analysis. Thus, in this study, the questionnaire was conducted to have a detailed understanding for the use of the OERs. The OCW questionnaire that was applied to students was provided in Appendix A.

As the summary of data collection methods, which methods were used to collect data from participants related with the system models were provided in Table 3.8 below.

Table 3.7 Data collection methods related with the system models

Sources of information	Data Collection Methods	System Model
TAs, professors	Interviews – Questions about the resources, expectations from the course, relation of the lab with main lecture, policies in relation with organizational practices Observation – course setting, boundaries Documents – resources of the course (lab book, videos, simulations)	Systems Environment Model
Students, TAs, professors	Interviews – Questions about the course requirements/purposes, use of the resources, performance outcomes, perceptions/attitudes to the course and resources, policies in relation with personal, resource and system related. Observation – resources, equipment, curriculum, components of the system Documents – details about curriculum, grades, OCW logs	Functions Structure Model
Students, TAs, professors	Interviews – questions about how the resources used, how the course maintained, how teaching and learning activities attained, experiences related with these components Observation – teaching and learning activities, assessment processes Documents - meeting notes about the current and future developments of the course and resources	Process Model

3.8 Data Analysis

3.8.1 Quantitative Analysis

For the quantitative data, questionnaire, logs and grades of the students in this study, descriptive statistics was used to determine the participants' demographic information (faculty, department, gender, gpa, number of getting chemistry lab course, number of lab experiment and OER use conditions). Fraenkel, Wallen and Hyun (2012) stated that "the major advantage of descriptive statistics is that they permit researchers to describe the information contained in many, many scores with just a few indices, such as mean and median" (p. 187). In addition, chi-square analysis, which is a nonparametric test for analyzing the categorical data (Field, 2009), was conducted to analyze in students' OER awareness and use conditions. In addition, Cramer's V was used to analyze the relation between their OER use conditions with awareness levels in the crossbreak tables. This data would provide a general portrait of the students' OER use in their chemistry lab course. Moreover, Mann-Whitney test was used to analyze the differences on users and non-users' grades in general chemistry laboratory course. Mann-Whitney test was selected that the data was not normally distributed and did not meet the parametric assumptions (Field, 2009), this test helped to compare the users and non-users grades.

3.8.2 Qualitative Analysis

In the second phase of the study, qualitative data analysis was followed for analyzing the interview, observation and documents data. Before the data analysis phase, Yin (2009) suggested to create a case study database in order to organize the data. This database is useful to serve the findings in a formal manner for other researchers so that from this view, this database can increase the transferability of the findings and so that the reliability of the study. There are four components in the database in terms of documents, notes, tabular materials and narratives. Especially in this study, collected data with diverse methods (interviews, observation, documents, survey instrument) were categorized based on these four components. After the creation of case study database, the interviews and observations were transcribed in a formal manner. During data collection and data analysis, the researcher created memos, which was a powerful tool that describes the nature in detailed (Johnson & Christensen, 2014). Memos were created based on the researcher's notes during the observation and interviews related with inferences of the researcher about the setting, behaviors, activities of the participants. In addition, some memos also added to the program while analyzing the data.

3.8.3 Interview & Observation

Yin (2009) proposes three general analytic strategies in terms of relying on theoretical propositions, thinking about rival explanations and developing a case description. In this case, theoretical propositions, which shaped the study to focus on the current, and desired data was used as an analytic technique while following the qualitative data analysis steps. This method is also work collaboratively with the theoretical orientation followed during the research process. These theoretical propositions (which were mainly defined at the beginning of the research by research questions and theoretical orientations) led the researcher to analyze the data based on some theories related with these propositions. While system theory was followed as a theoretical orientation to describe, collect and analyze the case, some theories were followed to examine the effects of OERs were used while analyzing the data. In addition, as a specific analytic technique, pattern matching was used which was described as comparing the predicted and current outcomes (Yin, 2009). While the patterns mostly refers to the explanations of themes in the data (Patton, 2002), this method helps the researcher to compare the predicted outcomes with the current data and also enable to search how and why these outcomes were happened. However, this approach was mainly used as analyzing and interpreting the data after creation of the codes and themes. For example, the proposition about the use of visual resources could increase the performance in laboratory setting was analyzed through how these resources effect the performance in laboratory setting. These kinds of propositions helped the researcher to draw the boundaries on data and to enable the pattern matching of data.

Gall, Gall and Borg (2007) summarized how to analyze case study data through three ways defined by Tesch (1990), in terms of interpretational analysis, structural analysis and reflective analysis. In this study, interpretational analysis was mainly followed to extract meaningful data from the data sources. For the interpretational analysis, five steps were determined as segmenting the database, developing categories, coding segments, grouping category segments and final conclusions.

In the first step, segmenting the database, all the data sources were added into the software program (NVivo 10), which helps to analyze qualitative data. Observation field notes, interview transcripts, memos, and documents were added to the program. These manuscripts were initially divided into segments, which points the meaningful parts of the data. (Johnson & Christensen, 2014), and also helps to define the codes which describes the meaningful parts of the data (Creswell, 2012).

In the second and third step, developing categories and coding segments, while the categories are defined before the coding section, in this case, firstly the segments were defined by codes or category names to label segments with meaningful names for the case. During the coding process, emerging codes were added to *the master list*, which shows the description, and definition of the codes (Johnson & Christensen, 2014). This process referred to the second step of developing categories, which was defined "a certain type of phenomenon mentioned in the database" (Gall, Gall & Borg, 2007, p. 467). After the data were coded, the codes were categorized which indicate the similar issues under a category. Two ways were followed while constructing the categories; inspiring by other categories, which were developed by other researchers (priori codes), and developing own categories (inductive codes) (Johnson & Christensen, 2014). For the former approach, the researcher benefitted from some studies in the literature as an inspiration but the latter approach was mainly followed. For the latter one, while the researcher had a former image of the possible categories based on the purpose of the study, the researcher mainly developed own categories. After determination of the categories and subcategories, each segment was assigned to the related categories. The researcher followed an inductive approach while creating categories and she reevaluated the codes during the analysis part multiple times by eliminating redundant codes and redesigning the current codes. Moreover, while deciding which of the categories were remained, two strategies were applied based on providing the frequency of how many people mentioned about a category and providing some significant and unique categories (Lincoln and Guba, 1981). Based on this approaches, the frequency of the codes mentioned by the researchers were provided through conceptually clustered matrix (Appendix G), which called enumeration (Johnson & Christensen, 2014) Thus, in this case, the researcher used enumeration to show how many participants mentioned each code.

In the fourth step, grouping category segments, this step includes combining similar segments and codes and also analyzing whether each code correspond to the category. Through software program, while the segments correspond to the same meaning were coded under categories, the similar categories were unified under themes, which portrays the data from a significant and holistic patterns in the study. In addition, description will be used to create a detailed visualization of the setting, events or people. Description is especially important for the ethnographic and case studies because description provides an idea about the setting where the action and people take place (Creswell, 2012). These themes and categories were presented Appendix G that shows the hierarchical relations between the themes and subthemes in order to draw some findings from the data. While defining the themes, it is also important to sense the saturation to minimize extra data collection (Creswell, 2012). In this study, the data revealed that the themes were developed and enough data were gathered which showed the similar findings through two data collection process. As summary, data collection and data analysis processes were shown in Table 3.9 below.

Table 3.8 Data collection and data analysis process

Target Group	**Data Collection**	**Type of material**	**Data Analysis**
Students (METE& MINE)	Interviews	Interview protocol	Interpretational Analysis for qualitative data (Gall, Gall & Borg, 2007)
	Observation	Observation protocol Usage checklist & mini-talks	
	Documents	Meeting notes, memos e-mails (METE & MINE), laboratory book, samples of assessments	
		Course grades, OCW user logs.	Descriptive statistics (Questionnaire & logs) Chi-square (Questionnaire) Mann-Whitney test (Grades)
Students (111/112 departments)	Questionnaire		
TAs	Interviews	Interview protocol	Interpretational Analysis
	Observation	Observation protocol	
Professors	Interviews	Interview protocol	Interpretational Analysis

3.8.4 Theoretical Orientations for Data Analysis

Regarding data analysis, two methods were used while analyzing data, inductive approaches were used to define codes, pattern and themes in the data and some theories for analyzing the data related with the second research question. Learning objectives and outcomes were mostly categorized under three domains as cognitive, affective and psychomotor (Martin & Briggs, 1986; Reigeluth & Moore, 1999). In this study, the researcher used this approach to classify the expectation and performance of the participants who used the resources in their course. Through these classifications, these outcomes might point does the resources facilitate the meaningful learning. However, the major purpose of this study was not to assess meaningful learning but the nature of laboratory setting comprises each of three domains so that the effects of using the resources naturally caused the outcomes in all three domains. In the Table 3.10 below, the coding process of performance outcomes was shown.

Table 3.9 Coding of outcomes from students group

Data exemplar	**Learning Domain**
#1) Lab sırasında ne yaptığını tam anlamıyorsun hani mesela bir şeyi bir şeye katıyorsun ama onlar ne bilmiyorsun çünkü orada bir not almaya çalıştığın için, işte bu kaynakları kullanınca biraz hani ne olduğunu hani yazılı olarak işte özellikle simulasyonda ne olduğunu anlayınca olayı hani anlıyorsun (SME #4)	#1) Cognitive
#2) El becerisi olarak etkisi oluyor, orada nasil tartılacağı, nasıl hangi sıvıların beherlere falan konulacağını gösterdiği için (SME #13)	#2) Psychomotor
#3) Ben temel olarak zayıf olduğum için benim için bu tür bir uygulama güzel bir uygulama yani beni laba gelirken en azından rahatlatıyor yani ben gerilen bir insanım yani geriliyorum toplum içinde bir şey yaparken yani o beni biraz rahatlatıyor (SME #6)	#3) Affective

3.8.4.1 Cognitive Domain

3.8.4.1.1 The Taxonomy of Educational Objectives

Bloom, Englelhart, Furst, Hill, and Krathwohl (1956) provided a taxonomy which classifies the learning in three domains; cognitive, affective and psychomotor. Four ways were described to follow the taxonomy in terms of defining educational objectives, defining items to measure the behaviors, evaluating the outcomes and analyzing the standardize tests (Bloom, Hastings & Madaus, 1971). In this study, the taxonomy was used through two ways as defining the objectives and evaluating the outcomes. For analyzing the data related with the cognitive domain, rather than Bloom's Taxonomy (Bloom et. al., 1956), the researcher used the revised version of the taxonomy (Krathwohl, 2002). While there are not major changes in each six category, the revised version uses two dimensions as knowledge category and cognitive process category. While knowledge dimension uses the similar categorization (also add metacognitive knowledge) with Bloom's taxonomy's first dimension *knowledge*, the revised version renamed this category as *remember* and evaluates each six category with the new knowledge dimension provided in the Table 3.11 below.

Table 3.10 The revised taxonomy table (Krathwohl, 2002, p. 216)

	Cognitive Dimension					
Knowledge Dimension	Remember	Understand	Apply	Analyze	Evaluate	Create
Factual Knowledge	x	x				
Conceptual Knowledge	x	x				
Procedural Knowledge	x	x				
Metacognitive Knowledge						

Related with the table above, the researcher classifies the outcomes through cognitive domains and explained them with which type of knowledge it contains (showed in the Table with x). In this study, two categories emerged remember and understand. While remember category refers to recall and recognition of knowledge, understand refers to achieving the meaning of knowledge (Krathwohl, 2002). In this study, the researcher used the classification for the first categories in the cognitive dimension. However, while the researcher classifies the remember category through the knowledge types (In here, the researcher unifies factual and conceptual knowledge based on the data), the understand (comprehension) category was not classified based on knowledge dimensions and it was evaluated based on interpretation skills of the students. Based on this categorization, the researcher analyzed the data as seen the Table 3.12 below.

Table 3.11 Example of data analysis based on taxonomy

Data exemplar	Cognitive Dimension	Knowledge Dimension
#1) Daha fazla malzeme var, kimyasallar var, hani kullandiğimiz şeyler her hafta farklı olabiliyor, beher gibi aparatlar dışında. Derece kullanıyoruz, bir hafta işte ısı yalıtımı kap kullanıyoruz. O yüzden her şeyi tanımamız için gerekli olduğunu düşünüyorum (SMI #15)	#1) Remember	#1)Factual-conceptual knowledge
#2) Ben sadece orada dinleyip ve her yarım saatte bir sürekli ne yapacağımı sorup deneyi bitirdiğim zaman bir şey anlamıyorum. Buraya gelip oturuyoruz arkadaşlar işlemler nasıl yapılıyor deyip teslim ediyorum. Yani deneye dair aklimda hiç bir şey kalmıyor ama öncesinde izlediğim sonrasında kendim uyguladığım deney olduğu zaman daha akılda kalıcı oluyor (SMI #8)	#2) Remember	#2)Procedural knowledge
#3) Yani neyi bulmamız gerektiğini yani o deneyi ne için yaptığımızı öğreniyoruz hani videoyu izleyince onu kavramış oluyorsunuz ve hani geldiğiniz zaman da quizde onunla ilgili bir soru olduğu zaman cevaplayabiliyorsun (SMI #7)	#3) Understand	#3)Interpretation

3.8.4.2 Psychomotor Domain

Psychomotor domain includes the practical activities to perform a task. Romiszovski (1999) mentioned that the psychomotor skills could be thought as a progression of reproductive-to productive. While the reproductive skills involve the application of a known or repetitive procedure, productive skills, productive skills involve the process of an unknown or strategic procedure, which refers to use new skills on a new situation. In here, skills described by three types as “totally reflexive and automated skills”, “skills that depend on the recall of a possibly complex, but essentially algorithmic procedure and the execution of series of linked actions in sequence" and "skills that depend on the analysis of incoming sensory information in order to formulate plans of action appropriate to the situation" (Romiszowski, 1999, p. 464-465). In this study, the psychomotor activities which students took action fell into the second type of skill that lies between the reproductive and productive skills but mostly refers to the reproductive skills. Thus, the researcher did not categorize the data under psychomotor outcomes by using reproductive and productive classification, she rather classified this domain under two categories based on the outcomes of this study as technique for using chemicals/equipment and duration of experimentation.

3.8.4.3 Affective Domain

Martin and Reigeluth (1999) defined the affective domain as "components of affective development focusing on internal changes or processes or to categories of behavior within affective education as a process or end-product" (p. 486). While affective development means to personal and social development, the affective constructs (values, morals, ethics, attitudes, motivation, feelings, and emotions) enable to categorize the affective outcomes. While there is some taxonomy for affective domain (Martin & Briggs, 1984), the researcher used the constructs to classify the affective outcomes in this study. While attitude construct was mainly used in this study, values and interest of the participants were mentioned some parts of the study. Attitude refers to "positive, neutral or negative responses to or evaluations about a referent, usually represented as position (pro or con) and intensity (strong to weak)" (Martin & Reigeluth, 1999, p. 494). Therefore the attitudes were provided under three parts, evaluations about the quality the resources, benefits and necessity of the resources.

3.8.5 Documents

For the documents in this case (laboratory book, the sample of quizzes and reports, e-mails, meeting notes, brochures, photographs of the setting), they were analyzed by using content analysis. Qualitative content analysis, which differs from the quantitative content analysis by reforming them on a quantified form (Gall, Gall &

Borg, 2007) were followed in this study. In here, similar inductive approach was applied for documents with the interview and observation data; however, the researcher categorized this data to support the findings of the other qualitative data.

For other types of documents, records, performance records and OCW logs were analyzed by using quantitative methods by using mainly excel forms. The grades of the students (between users and non-users) were compared and some graphs were provided to indicate the differences between their grades. In addition, OCW logs were added to the findings and helped the researcher to examine the frequency and number of usage of the resources.

Miles and Huberman (1994) proposed three parts of data analysis; data reduction, data display and drawing conclusion/verification. While data reduction (coding, categorizing process, writing memos, developing database), is a concurrent process with the data display, the latter one is a more form of understanding the process of what happened in the case. They defined the display as “an organized, compressed assembly of information that permits conclusion drawing and action” (p.11). Therefore, within the data reduction process, the researcher developed a conceptually clustered matrix, which enables to categorize all the data within key informants through the research questions (Miles & Huberman, 1994) (Appendix G). While this matrix facilitated to see the different data comes from the informants, it also displayed the responses for each of the research question. This process simplified to write the results of the study in a coherent way. After creating the matrix, which showed what happened in the case, the researcher created a causal network display, which showed why things happened in the case by drawing the relationship between variables (Miles & Huberman, 1994) (Figure 12).

3.9 Quality of the Research Design

For each type of research, validity and reliability issues are important for the quality of the study. However, Firestone (1987) criticized the difference between the strategies of qualitative and quantitative research to convince the readers for the results as “the quantitative study must convince the readers that procedures have been followed faithfully because very little concrete description of what anyone do is provided. The qualitative study provides the reader with a depiction in enough detail to show the author's conclusion makes sense" (cited in Merriam, 2009, p. 210). Therefore, validity and reliability issues will be examined based on the qualitative feature of this study.

Yin (2009) defined four tests that indicate the quality of research designs in terms of internal validity, external validity, construct validity and reliability. In literature, there are also different terms that define these terms for qualitative studies such as credibility (internal validity), transferability (external validity), and consistency/dependability (reliability) (Merriam, 2009). *Credibility* refers to the credibility of the inferences and results of the study (Merriam, 2009) and as the "accuracy of findings" that emphasized the process rather than a result (Creswell, 2007, p. 206). *Transferability* refers to the applicability of the findings for other situations (Gall, Gall & Borg, 2007). Here the term *transferability* covers a more meaningful idea that findings could be transferred in other concrete situations rather than the results come from abstract statistical generalizations in quantitative studies (Merriam, 2009). In this case, thick description and purposeful sampling approaches were applied. While Yin (2009) proposes another approach to increase the transferability as using single or multiple case studies by replication logic, it could not be practical to select many cases regarding time and source limitations for this case. However, within this case, the results could be helpful to provide an insight for how to use and integrate the resources in similar settings. *Dependability (Reliability)* covers the idea that collected data should have consistency with results of the study rather than getting the same results from the replication of a study (Merriam, 2009). For dependability, three strategies were used in terms of overlap methods, stepwise replication (Lincoln & Guba, 1985) and case study database (Yin, 2009). While the first approach similarly points the triangulation issue, which was mentioned on credibility, stepwise replication was defined in this research as the researchers who separately control the reliability of the data through inter-rater reliability issue. As a third strategy, Yin (2009) proposes to create case study protocol and database which includes case study questions, theoretical framework data collection procedures, and evaluation, which was mentioned in the methodology part for this case in detailed. For case study database, each type of data was mechanically recorded and added to a software program (NVivo), which enable to store them as raw data and also includes the reports of the researcher separately. *Confirmabilit*y refers to the idea of qualitative objectivity, which point neutral data comes from the participants without researcher's bias and influences. Correspondingly, Yin (2009) refers to the similar idea with the confirmability as *construct validity*, which similarly focuses on selecting appropriate data collection methods through regardless of subjective judgments. Several strategies were used for the elimination of the validity and reliability threats (Table 3.13).

Table 3.12 Strategies for threats of four tests (adapted from Lincoln & Guba, 1995 and Yin, 2009)

Tests	**Strategy**	**Strategy in this research**
Credibility	Prolonged engagement	Each semester, all classes were observed through the setting, activities and behaviors of the clients
	Persistent observation	Observations in each week were combined with memos Observation criteria were used to shape the observation process based on the purposes.
	Triangulation	Multiple sources of data Multiple methods of data collection
	Negative cases	Alternative explanations and different patterns were provided
	Peer Debriefing	Two another researcher helped during the data analysis process
	Member Checking	Some participants checked the information they given

Table 3.13 Strategies for threats of four tests (adapted from Lincoln & Guba, 1995 and Yin, 2009) (cont'd)

Tests	Strategy	Strategy in this research
Transferability	Thick description	Detailed description of the case through system theory
	Purposeful sampling	Purposeful sampling methods were used to increase the possibility of thick description of the case
Dependability	Overlap methods	Triangulation methods were applied
		Inter-rater reliability was applied with two other researchers
	Stepwise replication	All data was stored in a software program which includes both raw data and researcher's results
	Case study database	
Confirmability	Triangulation	Multiple sources of data and multiple sources of data collection
	Chain of evidence	Each data collection process were narrated and recorded and explained in detailed

3.9.1 Prolonged engagement &Persistent observation

Prolonged engagement, the researcher was an accepted and regular member in the setting that the students and teaching assistants behave her as one of the teaching assistants in the course. They mainly asked questions to the researcher about the experiments during the course. In addition, the relationship based on the trust between the researcher and participants were also important which was defined "a developmental process to be engaged in daily" to support the confidence and anonymity between the researcher and the participants (Lincoln & Guba, 1985, p. 303). Participating for each class and having conversation with the clients in the course enable the researcher to build a confident relationship with the participants of the study. Especially the students mostly saw the researcher as a guide whom they shared their experiences about the class and the teaching assistants and professors. This relationship also reinforced the idea of seeing the clients more than participants of the study. While the students were more distinct at the first two weeks of observation, they began to have more interaction with the researcher rest of the weeks. Related with the prolonged engagement, persistent observation provides in depth explanations of how these fieldwork is associated with the purpose of the study (Lincoln & Guba, 1985). In order to achieve this strategy, the researcher combined her field notes with her memos after the observation in each week. The researcher also prepared observation criteria to shape the field notes, which particularly match with the purpose of this study.

3.9.2 Triangulation

Triangulation is defined as validating the evidences by using multiple methods, multiple data sources, investigators, and theories (Denzin & Lincoln, 2005). In this study, multiple data sources (students, faculty members and teaching assistants), multiple data collection methods (interview, observation, survey) and multiple types of data (field notes, interview, and archival records) were used in order to corroborate the evidence. Johnson and Christensen (2014) defines multiple data sources is to collect data from different data sources (e.g. different individuals) rather than different data collection methods (interviews, observations etc.). In this study, three different data sources (students, teaching assistants, professors) that provided different perspectives for the phenomena of this study were selected and the data was collected from them through different time periods. As part of methods, while the researcher mainly followed case study method throughout this study, multiple methods of data collection process were applied. Interviews, observation, questionnaire and documents were collected to interpret the data. Regarding multiple theoretical perspectives, the researcher mainly used the system theory approach to portray the case as a system and its process; different approaches were used during data analysis process. However, when the data was consistent within two or more theories, this case was not applicable in this perception. The researcher used some theoretical orientations while analyzing data and while some of them had concurrent parts, they did not completely overlap to define the facts of the case. As Lincoln and Guba (1985) criticized, the multiple theories issue is not adaptable and coherent for naturalistic inquiry and also for this case. At the end, regarding multiple investigators, while the teaching assistants were naturally observers of students' behaviors in the classroom, they were not actual investigators in this study because of being a participant. They provided valuable data about the students' behaviors in the process, which facilitated to compare the researchers' field notes with their observations but they did not observe the environment as critical as the researcher did. Yin (2009) criticized that the validity should be considered throughout the study rather than only the data collection phase of the study. Thus, throughout this study, validity was supported with applying triangulation not only the data collection part, but also the design and the analysis phase of this study.

3.9.3 Negative cases

Negative case analysis refers to provide challenging data or alternative explanations in order to find other ways to explain different patterns in the data. In this case, the rival explanations and underlying explanations aimed to provide for a complete picture of the phenomenon. For example, related with the use of the resources, while most of the students were eager to use the resources, the barriers for their usage were provided. Moreover, for performance outcomes, while most of them mentioned to have some developments in their affective, cognitive or psychomotor domains, some of them reported no valuable change in their performance. Therefore, some explanations were provided for possible reasons of no change, which pointed a different pattern, contradict to the change of the performances.

3.9.4 Peer review/Debriefing

Peer review requires the individuals who ask the questions and offer suggestions to provide a different insight for the researcher (Creswell, 2007). For these long-term designs, a different perspective could be beneficial for the researcher so that throughout this study, the process and the phases of this study were discussed and analyzed with the researcher's supervisors and two peers. Besides weekly meeting with supervisors, two meetings were arranged at different times with two peers. At the first meeting, the researcher gave brief information about the research includes the purposes, research questions and information about the case. After the information, the results of the study were provided through the possible codes and themes emerged during data collection

3.9.5 Inter-rater Reliability

Lincoln and Guba (1985) was not very comfortable with the stepwise replication because of the unstable nature of the naturalistic inquiry, they proposed the researchers should communicate and deal with the changes, agreements and disagreements. In this study, the researcher applied this strategy during the data analysis process through inter-rater reliability process. For inter-rater reliability analysis, the researcher worked with two other researchers. They were both PhD students (one of them from IDT field and other one was from MSE field) who had coding experience before.

Two rounds were applied to complete *check-coding* which was a method to calculate the reliability (Miles & Huberman, 1994). For the first round, the researcher gave brief explanation about the study and the research questions for each coder separately. In this round, also the researcher and coders discuss each codes and themes the researcher extracted from the study. At the end of this session, the researcher gave the code list to the coders and gave 10% of the interview data for each coder. At the end, each coder had different 5 interview transcriptions (2 students, 2 TAs & 1 professor's transcriptions) to increase the reliability of the study. When the coders finish their coding process, the researcher compared the coder's codes with her own codes, created a table for agreements, disagreements, and noted some different segments of the data. Beside this table, the researcher calculated the reliability score by the formula of Miles and Huberman (1994) as dividing the number of agreements to sum of the number of agreements and disagreements. The reliability score was found .81 for the first coder and .80 for the second coder, which could be evaluated as good scores for the first round of check-coding.

For the second round, this time the researcher and two coders worked together to discuss the disagreements related with the study. The researcher noticed that the coders coded some segments of the data with some general terms like advantages or disadvantages of OERs but not the specific details of these advantages or disadvantages. In addition, they did not code some small parts of the data, which could show the researcher's insufficient information related with the study. Therefore, in order to discuss these differences, the researcher arranged a meeting with two coders. For this round, the researchers did not calculate reliability score, which was also obtained in the first round, rather she prefer to discuss the disagreements through the whole codes of data. As two third of data could be checked to reevaluate the revised and original versions (Miles & Huberman, 1994), the whole codes, categories and themes were discussed by the researcher and coders. This way seemed more sensible to have deeper understanding of the coders' evaluations about the data instead of calculating reliability score again. Thus, in the second round, the researcher explained the codes and themes in the study; the coders discussed the meaning, sense and validity of the codes and their interpretations while coding the data. At the end of this process, all codes were agreed but some of their names and some categorizations were changed to provide more understandable meaning for the readers without changing the meaning of the code.

3.9.6 Member Checking/Respondent Validation

Member checking requires the discussion with the participants to see the accuracy of the findings (Creswell, 2012). In here, the purpose is to validate the findings that emerge from the study through the eyes of your participants. Stake (1995) offers a strategy for member checking as rather than providing them transcriptions; the researcher could discuss themes through a focus group interview (cited in Creswell, 2007). Therefore, after the data collection and during the data analysis part, the researcher selected four participants (two from first and two from second semester) to check the transcriptions of their interviews. In addition, the researcher mainly applied this strategy during data collection if they mentioned and obscure information by asking repeatedly the meaning of the information given. After the transcriptions were given, they did not mention major problems but giving some detailed explanations for some of their answers.

3.9.7 Thick Description

Creswell (2007) and Lincoln and Guba (1985) associate the thick description with the transferability issue. During whole process of the study, detailed description of the each phase (setting, data collection, data analysis phases) provides to transfer the information to similar settings for other researches. In addition, the researcher also aimed to support the case to provide information within the system theory, which enables to analyze the case through holistic and detailed perspective. Moreover, the researcher used purposeful sampling methods to analyze the case with the rich informants from a broader sense to provide thick description of the case. Therefore, through this study, it is aimed to provide a detailed portray for the case in order to give common understanding for the practitioners for the use of OER in science lab courses.

3.9.8 Ethical Issues

Fraenkel, Wallen and Hyun (2012) defined the ethic as making decisions for the events "right or wrong". The ethical issues, which cover the participants, organizations/institutions, and the process of the research, are especially related with the researcher's role, validity and reliability of the study (Creswell, 2009). In each step of the research process, ethical considerations should be followed. First, during the process of defining the research problem and purposes, the research problems should be meaningful and beneficial for other researchers.

Second, in the data collection part, there are critical ethical considerations for the participants in terms of informed consent form, confidentiality, reciprocity, data access and ownership (Creswell, 2012). Elements of the consent form covers the "identification of the researcher, sponsoring institution, how participants were selected, purpose of the research, benefits for the participating, level and type of participant involvement, risks for the participant, confidentiality of the participant, guarantee for the withdrawal, and provisions of researcher's name" (Creswell, 2009, p. 89). Through these considerations, especially protecting the participants from harm and risky situations is the main important issue through the research process. In order to overcome this problem, consent form would be beneficial for the participants to get involved the whole research process (Fraenkel & Wallen, 2009). The psychological and physical effects of the research on participants should be considered.

Finally, in the data analysis and interpretation part, researcher should provide unbiased and accurate findings through an objective language and the anonymity of the participants should be kept (especially for the surveys) (Creswell, 2009). In this study, the permission from the university's Ethical Committee was provided (Appendix H). After that, informed consent form was provided to the participants in order to give information related with the research design. The participants were selected based on the willingness to participate the study for both the first phase and second phase of this study. Anonymity of the participants was sustained both for the qualitative and quantitative part of the study. In addition, any ethnic, social or cultural issues were mentioned especially during the data collection part.

3.10 Researcher's Role

Researcher's role is important especially for the qualitative study and there are also some ethical considerations through the research process. Creswell (2009) defines the researcher's role as providing a rich description for the context and purposes from the experiences, defining the connections between the researcher and participants, getting permissions for the ethical issues from the institutions/organizations, and getting permissions from gatekeepers. In this study, the context and the phenomenon was defined in detailed for both the participants and other researchers. Also, the interaction between the researcher and the participants was designed as assistant-student relationship but the researcher did not attempt to involve the course activities. Rather she only observed the students and took some notes regardless of disturbing the students and TAs' activities. During the mini-talks with students, the researcher informed the students that their usage profile of OERs did not affect their activities in the course academically or behaviorally rather they only informed to comprehend the purpose and the importance of this study. Thus, the probability of deception was aimed to decrease. However, the interaction between the researcher and the participant should have some boundaries. Creswell (2012) defines these boundaries for the researcher as "not a therapist offering advice or a judge evaluating the circumstances" (p. 231). Therefore, as a researcher, the role of the researcher was aimed to have an understanding without any personal judgments and relationships while analyzing the case and the phenomenon in depth

3.11 Limitations

Firstly, this study is limited with the resources in General Chemistry Laboratory Course that offered through OCW in Middle East Technical University. Other limitation is related with the participants that the students are only the participants of these courses, and the faculty members and laboratory-teaching assistants are only the members of Chemistry department. Another limitation of this study is related with the validity of the instrumentation that the validity is limited with the condition of the places where the survey is conducted, participants' reliable responses and the data collector's characteristics. Therefore, the findings and critiques of this study are limited with the METU Chemistry course case.

CHAPTER 4

RESULTS

The components and the processes of the systemic environment were shown in Figure 3. Based on the processes in the system, the results were provided under four themes in terms of use, implementation-adoption, performance outcomes and policy.

4.1 Use Theme

For the first sub-research question, the preparations for the course, usage profile of the resources, students' and the research assistants' reasons and barriers to use the resources were respectively provided. This process aimed to display the clients' activities before the class and their tendency to use the instructional resources in the course.

At the beginning of the first semester, METE group was selected as the experimental group and MINE group was defined as control group (Experimental and control group names did not refer to the experimental study. They were only used to show the different application groups). Responsible TA informed two groups verbally and the researcher at the beginning of the first class distributed informative brochures about the resources. However, the following procedure was differentiated between two groups. While experimental group was being informed before each class by e-mail, the control group was only informed before the fourth class. The aim of this procedure was to investigate whether this type of encouragement made a differentiation between students' usage profile. In the second semester, the groups were reversed that METE group is defined as control and MINE is selected as the experimental group. Within this procedure, the effects of the students and departments' characteristics were aimed to minimize.

4.1.1 Preparations for the Course

How students prepared for the course was one of the important questions in order to understand the students' behaviors and attitudes for the course. The selected participants provided in Table 5, 22 participants had the routine as reading the book and watching the video and simulation night before the class and 8 participants used the OERs only. They had different strategies like taking notes while watching the video, reading the lab book many times, watching different versions of the resources (English and Turkish versions). However, when the students mentioned to use both laboratory book and OERs, their purpose for using laboratory book was to be prepared for the quizzes rather than to understand the theoretical knowledge. One of the students mentioned this studying behavior through her experience:

> *Kitaptaki koyu kısımları okuyorum, videoyu izliyorum, simulasyona bakiyorum. Çok zamanım varsa videonun da ingilizcesini izliyorum (SMI #18)*
>
> *I read the bold parts of the book, watching the video, looking at the simulation. If I have a lot of time I watch English version of the video (SMI #18)*

Only two students mentioned that they began to prepare for the course couple of days before the class. However, 12 students mentioned that they only used the laboratory book to prepare for the course for some experiments (2 or more experiments). Particularly, while 3 of them prepared for the class approximately 30 min one day before the class, 9 of them mentioned to look over the laboratory book just 15 min before the class to prepare for the quizzes. In addition, derived from the observations, many students prepared for the experiments 30 min before the course. Students met their classmates before the class outside of the laboratory and studied on the laboratory book in the last minutes. Most of time, they were interested in the theoretical part of the book and most of them did not have any idea about the procedure of the experiment.

The reason for this kind of studying was analyzed based on the observations in the laboratory and interviews. One of the participants pointed this behavior as:

> Interviewee: *Kitabı yanıma aldıysam ki genelde alıyorum hocam hiç unutmadım herhalde unutsaydım zaten laba giremiyorum ya mesela Ata'yı bekliyorum mesela hani arabayla gelirken milli kütüphanenin önünde karıştırıyorum genelde sabah oluyor çalışmam işte*
>
> Interviewer: *O zaman sen gelmeden önce çok fazla hazırlanmıyorsun derse?*
>
> Interviewee: *Hiç hazırlanmıyorum hocam yani sabahları haricinde hazırlanmadım ona da hazırlanma denmez pek" (SMI #4)*
>
> Interviewee: *If I take the book, which I usually take it, suppose I never forgot that otherwise I cannot get into the lab. For example, I am waiting for Ata in front of the National Library; generally I look over the book while coming with the car that generally studying at morning.*
>
> Interviewer: *Then you do not get prepared much before you come?*
>
> Interviewee: *I did not prepare at all that I did not prepare except morning, which is not much preparation (SMI #4)*

One of the reasons highlighted about this last minute preparation was related with the pre-quizzes in the course and reliance on the TAs for the experimentation procedure. One of the students presented the issue as:

> Interviewer: *Peki, sen laba gelmeden önce nasıl çalışıyorsun dersem sadece lab öncesinde?*
>
> Interviewee: *Salı günü akşamı düşünüyorum yarın labım var mı? Labım var, sabah kalkıyorum, kitaba bakıyorum, sürece bakıyorum ne çıkabilir. Koyu yazılmış yerleri bir gözden geçir bunlardan çıkabilir, o şekilde hazırlanıyorum. Prosese de çoğu zaman bakma imkânım olmuyor, quize çalışmaktan çünkü öncelik her zaman quiz. Nasıl olsa prosesi anlatıyorlar diye düşünüyorum (SME #8)*
>
> Interviewer: *So, how do you study before you come to the lab?*
>
> Interviewee: *I think on Tuesday evening that whether I have lab tomorrow. I have lab, I wake up in the morning, I look at the book, I look over the process what possibly asked from there. Take a look at the bold sections, which could be asked from, that's the way I'm getting ready for. I often do not have a chance*

to look at the process because of studying on quiz, because quiz is always in the first priority. I think that they are telling the process in anyway (SME #8)

Therefore, that the students had different preparation strategies which pointed some problems in the system. The assessment system (quizzes) and the teaching process were the most mentioned issues, which directed students to have a less time for preparation. In addition, the second most highlighted issues were the lack of interest for the course and the perceptions and traditions about the course, which would be analyzed in many sections in the results of this study. On the other hand, the resources seemed to increase the students' preparation time as seen from one of the students' quote:

Materyallerden önce (ilk dönemden bahsediyor) buraya biraz erken gelip arkadaslarla kitap okuyorum quizlerden hani bir iki soru için bakıyordum yoksa onun haricinde bir hazırlanma yapmıyordum (SME #5)

I came to the lab a little earlier (mean the first semester) and read the book with friends that I was looking for a question or two for quizzes, otherwise I did not make any preparations other than that (SME #5)

Beside students, teaching assistants had a preparation process for the laboratory course. The experienced assistants did not need to use the resources; they mainly used the laboratory book to remember the content for the experiments. Relatively inexperienced assistants had more detailed preparation process, which included laboratory book and OERs. Therefore, in the next section, the students' and teaching assistants' reasons and the barriers to use the resources would be provided.

4.1.2 Usage Profile

Based on the results of the questionnaire, the demographic data showed that 57.4% of the students were male and 41.9% were female. In terms of the responsible departments for 111/112 course were METE (19.8%), MINE (16.2%), GEOE (17.8%), PETE (10.6%), GENE (9.2%) and CHE (26.4%) (Table 4.1).

Table 4.1 Demographic information of questionnaire participants

Gender	*f*	%
Male	174	57.4
Female	127	41.9
Department	*f*	%
METE	60	19.8
MINE	49	16.2
GEOE	54	17.8
PETE	32	10.6
GENE	28	9.2
CHE	80	26.4

Based on the results of the awareness and usage of the OERs in chemistry laboratory course (Table 4.2), 65.3% of the students were aware of the OERs while 34.7% of them did not. However, 117 students (38.6%) used the OERs among 303 participants. Among users, nearly half of the students (43.6%) used the OERs in couple of times before the lab and 34.5% of them used the OERs before each laboratory. Regarding the which material they used, the videos were prominent ones that 75.9% of the users watched videos only and 16.7% of the users preferred to use both videos and simulations.

Table 4.2 Awareness and usage profiles of questionnaire participants

Awareness	*f*	%
Yes	197	65.3
No	105	34.7
Usage	***f***	**%**
Yes	117	38.6
No	185	61.3
Frequency of use	***f***	**%**
Before each lab	38	34.5
After each lab	1	0.9
Before and after each lab	6	5.5
Sometimes before lab	48	43.6
Sometimes after lab	3	2.7
Sometimes before and after lab	2	1.8
Only once	11	10
Material type	***f***	**%**
Video	82	75.9
Simulation	8	7.4
Both	18	16.7

Based on the results of observation, each week in two semesters, every student's using activities were followed and observed. Among 18 students, 6 teaching assistants in the first semester, 20 students, and 5 teaching assistants in the second semester, the selected participants' usage profiles for each semester were shown in the Table 4.3 below.

Table 4.3 Frequency of using the OERs through departments

Student (First Semester)	Frequency of using the resources	Type of the material	Department
SME #1	3 exp (1 Video, 3 Sim)	Video & Sim	METE
SME #2	5 exp (5 Video, 1 Sim)	Video & Sim	METE
SME #3	3 exp (3 for each)	Video & Sim	METE
SME #4	4 exp (4 for each)	Video & Sim	METE
SME #5	4 exp (4 for each)	Video & Sim	METE
SME #6	5 exp (5 for each)	Video & Sim	METE
SME #7	3 exp (3 Video)	Video	METE
SME #8	2 exp (2 for each)	Video & Sim	METE
SME #9	5 exp (5 for each)	Video & Sim	METE
SMI #1	1 exp (Video)	Video	MINE
SMI #2	5 exp (5 for each)	Video & Sim	MINE
SMI #3	2 exp (2 Video, 1 Sim)	Video & Sim	MINE
SMI #4	2 exp (Video)	Video	MINE
SMI #5	1 exp (Video)	Video	MINE
SMI #6	1 exp (Video)	Video	MINE
SMI #7	2 exp (2 for each)	Video & Sim	MINE
SMI #8	2 exp (Video)	Video	MINE
SMI #9	2 exp (Video)	Video	MINE
TA (First Semester)	**Frequency of using the resources**	**Type of the material**	**Responsible Department**
TA #1	5 exp (Video)	Video	MINE
TA #2	5 exp (Video)	Video	METE&MINE
TA #3	5 exp (5 for each)	Video & Sim	MINE
TA #4	3 exp (3 Video, 1 Sim)	Video & Sim	METE&MINE
TA #5	5 exp (5 for each)	Video & Sim	METE&MINE
TA #6	No use, only knows the OERs	Video & Sim	METE&MINE

Student (Second Semester)	**Frequency of using the resources**	**Type of the material**	**Department**
SME #10	3 exp (3 video, 1 sim)	Video & Sim	METE
SME #11	2 exp (2 for each)	Video & Sim	METE
SME #12	3 exp (Video)	Video	METE
SME #13	4 exp (4 Video, 3 Sim)	Video & Sim	METE
SME #14	2 exp (Video)	Video	METE
SME #15	3 exp (Video)	Video	METE
SME #16	3 exp (3 for each)	Video & Sim	METE
SME #17	3 exp (3 Video, 1 Sim)	Video & Sim	METE
SME #18	2 exp (Video)	Video	METE
SME #19	5 exp (5 for each)	Video & Sim	METE
SMI #10	3 exp (3 video, 1 sim)	Video & Sim	MINE
SMI #11	4 exp (4 for each)	Video & Sim	MINE
SMI #12	4 exp (4 for each)	Video & Sim	MINE
SMI #13	4 exp (4 for each)	Video & Sim	MINE
SMI #14	5 exp (4 Video, 5 Sim)	Video & Sim	MINE
SMI #15	5 exp (5 for each)	Video & Sim	MINE
SMI #16	1 exp (Video)	Video	MINE
SMI #17	5 exp (Video)	Video	MINE
SMI #18	4 exp (5 for each)	Video & Sim	MINE
SMI #19	4 exp (5 for each)	Video & Sim	MINE
TA (Second Semester)	**Frequency of using the resources**	**Type of the material**	**Responsible Department**
TA #7	5 exp (5 for each)	Video & Sim	METE&MINE
TA #8	5 exp (5 for each)	Video & Sim	METE&MINE
TA #9	No use, only knows the OERs	Video & Sim	METE
TA #10	No use, only knows the OERs	Video & Sim	METE
TA #11	No use, only knows the OERs	Video & Sim	MINE

According to the Table 16, more than half of of the students (N=30) and research assistants preferred to use both video and simulation among 49 participants (students and TAs), 14 participants among these users (N=30) used resources for every experiment. 15 of them only used the videos for different experiments and 4 of them only discovered the OERs for their preparation process. It is also significant to note that most of the users were preferred to use the videos rather than simulations.

Regarding the user profiles in two departments (every students in METE and MINE groups), 57 students (among 94 students) and 5 assistants used the resources at least one time in the first semester; in the second semester this number was 68 (among 108 students) and 2 assistants. Regarding the *first semester* (Figure 4.1), METE group of students (experimental group) had a sustainable user profile for each experiment than MINE group (control group). However for the 4^{th} week, which the information was given to MINE students, had reached the highest user activities for MINE group of students. On the contrary, in the *second semester*, MINE group of students (experimental group) have higher usage activities than METE group (control group) (Figure 4.2). Moreover, METE group again had the highest usage activity on the 4^{th} experiment. As no information was given each group about the OERs in the first experiment, the usage activities was very low as expected. Regarding the teaching assistants, the experienced ones (N=4) did not use the resources while the others preferred to use the resources for their own learning and teaching process.

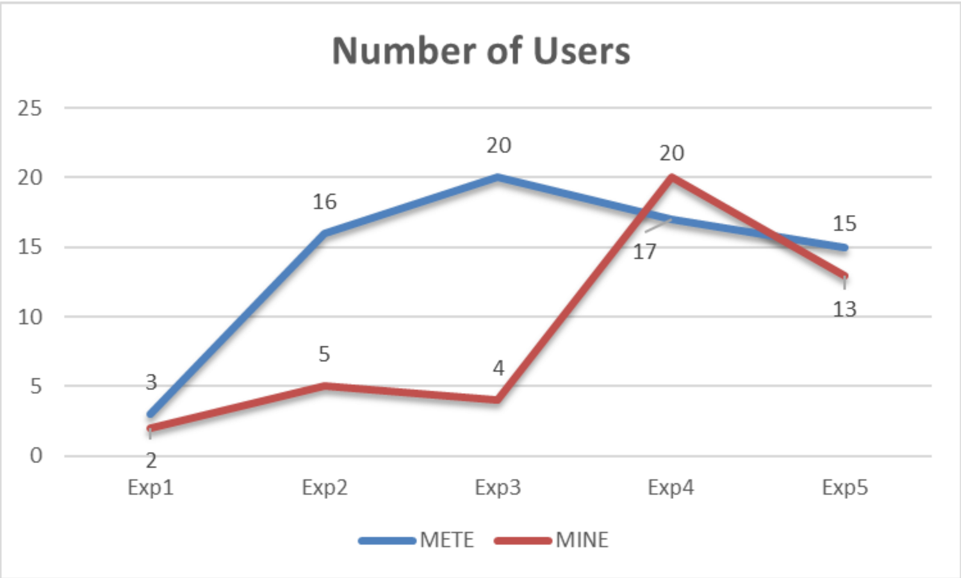

Figure 4.1 Number of OER users (students) in the first semester (2013-2014 Spring)

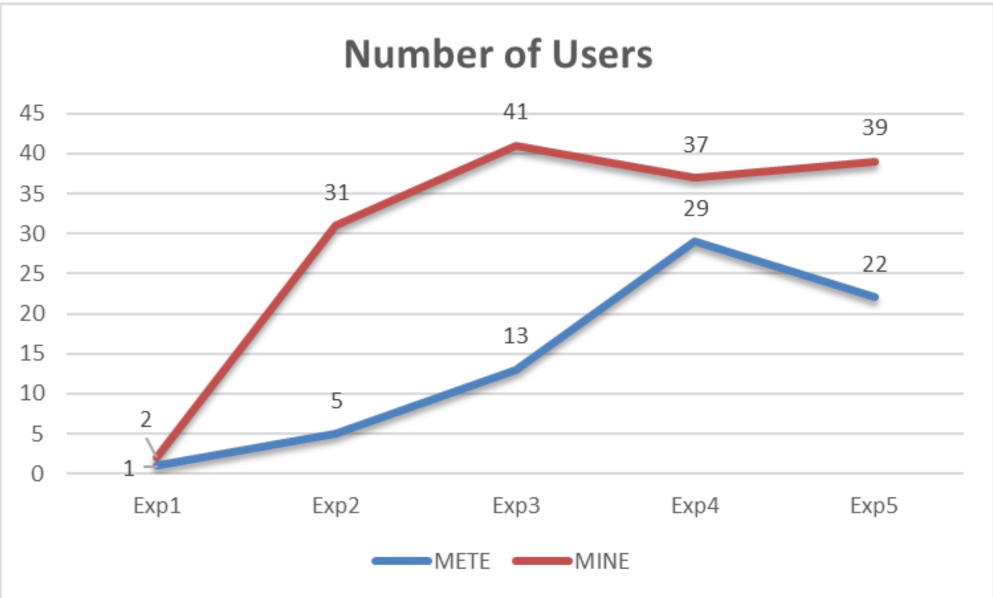

Figure 4.2 Number of OER users (students) in the second semester (2014-2015 Fall)

4.1.3 Reasons to Use the OERs

In this part, students' and the research assistants' reasons to use the resources were respectively provided. Based on the results of the questionnaire, 101 students among

117 users mentioned to use the OERs to prepare for the course, seven of them mentioned to use the OERs for both preparation and repetition and two of them used the OERs to explore the environment. Related with the results of the questionnaire, the qualitative results, which corresponded with the motives for students to use the resources, were divided into two categories: intrinsic and extrinsic motives.

4.1.3.1 Intrinsic Motives

As intricsic motives, three categories were emerged: to be prepared for lab, the characteristic of the OERs and curiosity. The most highlighted intrinsic motive was being prepared to have a prior knowledge about the experiments. 14 students mentioned that they used to resources to be prepared for the course. Among them, seven students preferred to use the resources to know the procedure of the experiment as explained by a student below:

> *Ya ilk başta hani deneyde yapacaklarımla ilgili işte bana bir önbilgi verir hani ne yapacağımı ne edeceğimi önden olarak bir şeyler öğrenirim hani yardımcı olması amacında deney esnasında bu sebeplerden ötürü kullandım yani (SMI #3)*
>
> *At first I used them for the purposes of giving me information what I am going to do in the lab, learning something what I am going to do in advance, helping me during the experiment (SMI #3)*

In addition to have a prior knowledge about the experiments, some of the students (N=4) used the resources to see how to use chemicals and equipment during the class. One of them expressed his reason to use the resources as indicated below:

> *Çünkü bir gün sonraya hazır gelmek daha güzel oluyor ve ne yapacağımızı bilmek, hangi malzemeleri kullanacağımızı bilmek, ne tür araçlarla çalışacağımızı bilmek iyi oluyor dersten once (SMI #15)*
>
> *Because it is better to come prepared for the day after tomorrow, and it is good to know what to do, what materials to use, what kind of tools to work with before the class (SMI #15)*

For some students, feature and characteristic of the OERs was one of the reasons for selecting them. Firstly, the visual and interactive environment played a key role for some students (N=8) to prefer the resources rather than printed material (laboratory book in this case). A student mentioned her choice in following comment:

> *Çünkü ben her zaman için böyle videolu olan şeyleri daha çok seviyorum bilgisayar ortamında mesela normal derslerde de sınavlardan once açıp hanı MIT'nın ya da diğer üniversitelerin videoların izlerim ya da işte soru çözümlerine bakarım bir konuyu anlamadıysam onu internete yazar direk onunla ilgili bir video izlerim o yuzden hoşuma gitti (SME #9)*
>
> *Because I always love things with videos in the computer environment, for example in the formal course, I watch the videos of MIT or other universities or look the problem solving videos before the exams, I search a content on the internet and watch related videos if I do not understand it, so I liked it (SME #9)*

In accordance with this issue, the quality and the language of the laboratory book directly affected the choices of these resources. In this system, officially offered instructional resource was laboratory book that students had problems to understand. The students who had difficulty to understand the experiment with laboratory book could be divided into two categories: the ones suffered from the complicated content knowledge in the book (N=5) and the ones having problems with foreign language (English) (N=2). One of the students in the first category clarified this issue as:

> *Öncelikle kitaptan çalışmaya başladığımda bazı anlamadığım terimler vardı ve hani deneyin nasıl işlediğini falan tam olarak anlayamamıştım. Videoda uygulamalı gösterdiği için, deneye geldiğimde en azından ne yapacağım hakkında daha fazla bilgim oldu (SMI #13)*
>
> *First, when I started studying on the book, there were some unfamiliar terms and I could not fully understand how the experiment works. Because the video shows as practical, I had more information about what I would at least do when I began to the experiment (SMI #13)*

The second category related with the preference of OERs over laboratory book revealed the importance of language opportunity in the OERs. Language deficiency directed the students to find alternative resources so that the Turkish version of the

OERs helped the students at least to understand the procedure of the experiment. A quote related with this issue was provided below:

> *Açıkçası söylemem gerekir ki, deneylerin Türkçe versiyonu benim çok işime yaradı, başta bunu söylüyorum çünkü bence İngilizcem çok yeterli değil (SME #8)*

> *Actually, I must say like that, Turkish version of experiments in there worked a lot for me, firstly I said so because I think my English is not such enough (SME #8)*

Other reason indicated by students also shows that curiosity enhances their motivation to use these OERs (N=5). Two of them mentioned that simulation environment attracted their interest on using them.

Beside students, research assistants also benefitted from these resources for their own advantages. While some assistants had many years experience in laboratory courses (N=4), more than half of them were new at this experimentation (N=7). Except for two assistants, rest of them used or looked over the OERs before the semester began. Between these profiles, the reasons to use them might vary from using them for getting some teaching ideas to for learning the procedure of the experiment. Especially new research assistants used them both for teaching and learning activities, the experienced ones looked the OERs only for teaching purposes to see how to transform the content in actual laboratory setting (N=8). One of the teaching assistants explained her reason to use from her teaching experience:

> *Aslında bir de ilk asistan olduğumda sonucta hiç laboratuvara girmedim hiç ders anlatmadım. Onların nasıl yapıldıklarına bakmak için onun amacıyla bakmıştım yani o şekilde asistanlıkta kullandım (TA #5)*

> *Actually, when I first became an assistant, I did not have experience on laboratory and did not teach at all. In order to look at how the experiments were conducted, I used them for teaching as assistant (TA #5)*

Some new teaching assistants also used the resources for their own learning process (N=3). One of them stated her learning process as:

Kullandım çünkü şey normalde dönemin başında deneyleri yapmamız gerekiyordu ama bizim bir kongreye gitmemiz gerekti, dolayısıyla burada olamadım, deney yapamadım. O yüzden de konuyu çalışıp, konuyu öğrencilere anlatmadan önce konuyu çalışıp muhakkak hani hiç deneyimim olmadığı için onları izlemeye çalıştım mümkün olduğunca (TA #8)

I used them because we had to conduct the experiments at the beginning of the semester but we had to go to a congress, so I could not be here, I could not do the experiments. Therefore, I tried to study on the subject, before teaching the students that I tried to watch them for sure because I did not have any experience (TA #8)

On the other side, the research assistants also use these materials as a reminder before they come to the class. The resources helped them to recall the process of the experimentation before the class. However, most of the teaching assistants mentioned that they could understand and apply the process by only using laboratory book but the OERs made the process easier and shorter for them.

4.1.3.2 Extrinsic Motives

Beside intrinsic motives, four extrinsic factors also affected the usage process of both students and TAs. In this case, firstly, three students mentioned the importance of being informed properly at the beginning of the course by an assistant and by researcher (N=3), which increased the students' recall to use them in each week. One of the students expressed his behavior as:

Bu dönem siz msj mail attığınızdan dolayı hani en azından hani bu hafta ne yapacakmışız ya filan diye böyle bakıp ııı bakabiliyoruz yani bu bence insanların bilgilendirilmesiyle alakalı (SME #1)

This semester, because you sent e-mails, at least we can look over what we will do this week so I think it is related to informing people (SME #1)

In addition to that, secondly, the social influence (N=2) also had an effect on students' preferences. A student expressed his usage motivated by a friend of him:

111' i aldığım zaman da arkadaşlar soylemiştiler ben kullanmamıştım onu ama 112'de baktım ki faydası oluyormuş gerçekten yani çünkü işte bir arkadaşım var lab arkadaşım o söylemişti bir bak yani istersen diye (SME #2)

When I took 111, my friends said but I did not use it, but I noticed that it was beneficial indeed because I have a friend who said me to look over them (SME #2)

Other important factor related with the extrinsic motive was about improving grades. While some of the students did not have a prior motivation for their grades by using the OERs, some of them (N=6) used the OERs to get higher grades in the course especially for quizzes. A student explained his reason to use as:

Yani en büyük nedeni bu hani bir şeyde de giriş quizinde de hani yardımcı olur diye düsünüyorum oldu da zaten o yani (SME #7)

The biggest reason is to think that it could help for the pre-quiz so it helped as well (SME #7)

The last extrinsic motive to use the OERs was to have an expectation for finishing the experiment earlier. Beside the previous three extrinsic motives, this was the most stated issue, which guided the students to have a shorter period in the course environment. (N=7). One of the students expressed her reason as:

Şunu yaptıktan sonra ne yapıyorduk falan diye en azından hani daha bilip gidersek daha çabuk halledebiliriz diye sonucunda çünkü rapor falan da yazıyoruz uzun sürüyor hani daha çabuk bitirsek daha çabuk hallederiz diye yaptım yani (SME #5)

At least we know the process for what have been doing after we did this, we will be able to take care of it more quickly, because we write a report, which takes long time so I used it to finish and handle the experiment earlier (SME #5)

Therefore, spending less time on experimentation process triggers the students' motive to use the OERs.

4.1.3.3 Sustain to Use the OERs

Most of the participants (N_s =17, N_{ta} =5) who used the resources at once, continued to use them to the end of the semester. They described their persistence to use these OERs as to notice the effects of them on their performance. The dialogue between the interviewer and the interviewee demonstrated this issue:

> Interviewer: *Peki sen neden bu materyalleri kullanmaya devam etmeyi seçtin?*
>
> Interviewee: *Çünkü baktığımda büyük bir kolaylık sağladığını gördüm lablar için hem videoyu görüyordum hem aklımda kalıyordu deney asistanının anlattiklari havada kalmiyordu bu yuzden kullandim, notlarima ve kimya dersine çok yardımcı oldular ki kullanmaya devam ettim (SMI #2)*
>
> Interviewer: *So why did you sustain to use the resources?*
>
> Interviewee: *When I looked at it, I saw that it gave me great ease for the labs, I was watching the videos and it was catchy in my mind which were supported with the teaching assistants' told, so I continued to use because they helped to my grade and chemistry course (SMI #2)*

The second indicator for sustainability was to send an e-mail as a reminder for the course for some students (N=3). This e-mail alerted the students to use the OERs and to prepare for the course.

> Interviewer: *Size her hafta mail atmasaydım sen yine de kullanmaya devam eder miydin?*
>
> Interviewee: *Etmezdim çünkü hani onun rutine binmesi biraz zor hani laboratuvar genelde çalışılmadan gidildiği için hani önceden mesela bir ödevi yok bir şeyi yok o gün yapıyorsun ve bitiyor o yüzden hani eksikliğini duymam yani aaa bak iste laboratuvar var buna çalışmam lazım demem ya gittiğin zaman zaten herkes o anda bir şeyler yapmaya çalışıyor (SME #4)*
>
> Interviewer: *If I did not send e-mails in each week, did you sustain to use them?*
>
> Interviewee: *I did not because it was a bit hard to put it on the routine, but the lab is usually gone without studying, so there is not an assignment or anything, you do it and it ends so that I did not feel the lack of them that I did not say myself the need of studying on lab because everyone is trying to do something at that time (SME #4)*

As seen in the quote above, the regular notification and information provided an external motive for the use of OERs. In here, it is important to mention that e-mails were defined essential for providing the first information and most of the users were satisfied to receive e-mail about the OERs. However, e-mail was defined as a motivator rather than a reason to sustain to use the resources so that the main reason for sustainability was to see the benefits of the OERs. As mentioned in the course preparation part, the perceptions about the system also affected the students' use of the OERs. In addition to that, two assistants maintained to use them especially to recall the process of experimentation.

4.1.4 Reasons not to Use the OERs (Barriers)

The results of the questionnaire showed that 61.3 % of the students did not used the OERs. Among these non-users, 56.3% of them did not aware of the OERs. The rest of non-users who were aware of the OERs (43.6%) responded the barriers to use them as no need (33.7%), lack of time (16.8%), and other problems (not aware of the OERs' usability, no friend use and no idea of the OERs' function). In correspondence, the results of the qualitative part showed that there were many barriers to use the OERs in terms of student-related, course-related, resource-related and external factors. The next sections aimed to unify the results from two sources of data.

4.1.4.1 Student-related Factors

There were many factors affected by the students' behaviors and attitudes towards the course and OERs. The most highlighted reason not to use them was the lack of interest for the general chemistry course as a whole (N=8). For most of the students, general chemistry course did not have a major effect on their academic life. They did not have enough interest for both the main course and laboratory course. A student explained this issue in dialogue below:

> Interviewee: *Mesela bizim kendi bölümümüzde (Maden Mühendisliği) bazı öğrenciler diyor ki arkadaşlar falan yarın deneyde ne yapacağız diyor, onun haberi yok diyorum ki iste videosunu göndermişlerdir, orada bir simülasyon vardı falan diyorum*
>
> Interviewer: *İlgilenmiyor mu?*

Interviewee: *Belki de, dediğim zaman açıp izleyebilse belki de. Onlar için çok önemli bir ders olmadığı için. Açıkçası dersten ziyade bolum de önemli olmadığı için de olabiliyor çünkü ben bazen duyuyorum, diyor ki ağabey makina mühendisliği olsa çalışırım ama maden mühendisliğine kim çalışır. Tercih meselesi (SME #10)*

Interviewee: *For example, some students in our department (Mining Engineering) say what are we going to do in the experiment tomorrow, she/he did not know so I say they should have send videos and there were simulations in there*

Interviewer: *Is she/he not interested?*

Interviewee: *Maybe, if she/he could just watch it when I said. For them it is not a very important lesson. Obviously, more than course, the discipline is not important because sometimes I hear, says if it is mechanical engineering I would study but who works in mining engineering. It is choice of matter (SME #10)*

As mentioned in the quote above, the student also highlighted the problem in some departments. Some students also did not have enough motivation and interest for their own department so that this course did not provide any profession on their academic life.

Teaching assistants in the course also remarked this issue as the general problem faced in the GCLC system (N=6). Most of the students, which did not have Chemistry-related courses in undergraduate programs, were described as less interested students. One of the teaching assistants characterized this problem as indicated below:

Interviewer: *Peki sence bu genel kimya öğrencilerinin bu sistemi kullanmamasının sebebi…*

Interviewee: *Kimya öğrencileri olmamaları birinci sebep bu. Çünkü onlar zaten bunu ya bizim bir kimya dersimiz var diye gerçekten birazcık böyle lanet ederek alıyorlar. Tabii ki çoğu değil ama…*

Interviewer: *Kimyayla çok alakalı olmayan bölümler belki.*

Interviewee: *Kesinlikle. Atıyorum şu an kimya mühendisliğinden bahsetmiyorum zaten. Mesela bir bilgisayar mühendisi, bir makine mühendisi. Yani kimyayı hayatı boyunca görmeyecek insanlar, gerçekten. Onlar için* *gelelim, 6 hafta, 6 deney, bitsin ve gidelim modundalar. Onun için onlar çok fazla ilgisizler bu konuda ve geçelim, DD alayım geçeyim diye bakan öğrenciler. Dolayısıyla onların çok da ilgisini çekmiyor. (TA #3)*

Interviewer: *So in your opinion what is the reason of general chemistry students' not using the system…*

Interviewee: *This is the first reason that they are not chemistry students. Because they are actually taking it by cursing it a little bit. Of course not many, but ...*

Interviewer: *Maybe non-related chemistry majors*

Interviewee: *Absolutely. I'm not talking about chemical engineering at the moment. For example, a computer engineer, a mechanical engineer. I mean people who will not see chemistry through life, really. For them, it is like let's come, 6 weeks, 6 experiments, over and go mode so that they are very much uninterested in this matter and they are the students who want to pass, to pass with DD. Consequently, it does not take much of their attention (TA #3)*

The second most expressed issue was the lack of time to spend to use the OERs (N=10). The results showed that except personal problems, the resources were not in students' primary priorities on their academic life (N=3) and they were not accustomed to the resources (N=2). They did not want to spare their time with this course if they had another responsibility for other courses.

Vaktim olmadığı için kullanmadım. Sınav haftasına denk gelmişti büyük ihtimalle. Bir de salı günü benim 8 saat dersim var. Aksam eve gidip direk uyumak istiyorum. Video aklıma gelmiyor (SME #15)

I did not use it because I did not have time. Most probably, it was the exam week. I also have 8-hour lesson on Tuesday. I want to go home and go to sleep directly. Video does not come into my mind (SME #15)

In addition to that some students (N=6) mentioned that they forgot to use the resources because of the frequency of laboratory courses and the priority of this course in their academic life.

Kimya labları iki haftalık periyodlarda olduğu için bir gün öncesinde ona hazırlık yapmak pek aklıma gelmiyor açıkçası (SMI #8)

Since the chemistry labs are in the period of two weeks, actually it does not come into my mind to prepare for it in a day before (SMI #8)

Another student-related factor was the level of experience in laboratory environments. For some students (especially in the first semester in data collection) (N=2), the additional resources were defined unnecessary to use because they already knew how to do the experiment:

Portalı neden kullanmadım çünkü kimya labımda verilen süre zarfının, deneylerin yani her şeyin yeteri düzeyde yapılabilecek düzeyde olduğu için hani. Herhangi bir çekincem olmadığı için kimya labından o yüzden hani kullanmadım. Nasıl olsa yapıyorum diye hani yapabiliyorum mantığıyla. Sonuçta yeni ilk dersi alırken genel kimyanın ikinci dersi, ilk dersi alırken muhtemelen bütün haftalarda kullanırdım ama şuan biraz daha deneyim olduğu için yani kimya labında ne yapacağımı bildiğim için daha farklı hani durumum (SMI #9)

Why I didn't use the portal is because the time given in chemistry lab is long enough for experiments and everything. I didn't use it because, you know, I didn't have a reason to. I could already do. I would probably use it every week, of course, when I was taking the first lesson – second lesson of general chemistry. But now I have some experience; I know what to do in the chemistry lab, so I'm in a different situation (SMI #9)

Similar with this perception, some teaching assistants also did not need to use the resources (N=4). The level of experience in the course definitely indicated their behavior in this case, which a teaching assistant stated as:

Interviewee: *Daha önce kullanmadım, şöyle ben ilk asistanlığa başladığım dönemlerde böyle bir şey yoktu, video ve simülasyon web sitesinde. Biz kendimiz yapmıştık bütün deneyleri hani deneyimleme acısından öğrencilere yaptırmadan önce kendimiz yapmıştık. Daha sonra böyle bir şey çıktı*

Interviewer: *Sonra da gerek duymadın mi?*

Interviewee: *Evet çok ihtiyaç duymadım çünkü zaten deneyleri yapmış ve biliyordum (TA #11)*

Interviewee: *I have not used it before, in fact there was nothing like that videos and simulations in the website when I first began my assistantship. We conducted all the experiments ourselves for having experience before having students to do the experiments. Then, this thing came out*

Interviewer: *And did you not need it then?*

Interviewee: *Yes I did not much need because I had conducted the known the experiments (TA #11)*

Thus, the OERs were mostly preferred by inexperienced students and teaching assistants for this laboratory course.

4.1.4.2 Course-related Factors

Two issues constituted the course related factors, which negatively affected to use the OERs. Regarding the first issue within the data from observations and the interviews, both faculty and students did not value the General Chemistry Course enough. The first perceived value about the course, which was also naturally associated with the students' interest for the course, indicated the problems related with the perceptions about the department (N=2). The perceptions about the Chemistry department affected the students' values and interests about the courses offered in the department. A faculty member pointed the issue as indicated below:

> *Ya kimsenin taktığını düşünmüyorum tamam mi, öğrenciler geliyor daha cok zaten toplumda kimyanın fiziğin iste biyolojinin pek bir karşılığı olmuyor, siyasetçiler dahi diyor ya niye kimse matematik, fizik, kimya, biyoloji derslerinin seçmeli olmasını tartışmıyor diyor ya. Simdi o olunca halka yansıması farklı oluyor. Yani sen ne okuyorsun mesela bizim üniversite içinde, bizim birinci sınıfların ve hazırlık öğrencilerinin moralinin bozuk olmasının sebebi sen kaç puanla geldin, hangi bölüme girdin Kimya mi? Hii… Ya iste puanı düşük. Bu bizim zamanımızda da böyleydi. (P #4)*

> *Well, I don't think anybody cares. You know, students are coming and mostly the society doesn't appreciate chemistry, physiscs or biology. Even the politicians ask why maths, physics, chemistry or biology lessons are not selective courses. So, naturally it reflects in that way to the society. Take our university for example, most of the students are unhappy, because people ask questions like "what's your grade; which department do you study; chemistry? Well that's a bit low". It was the same when I was a student, too (P #4)*

The second perceived value of the system was related with the traditions in the course. As mentioned in the preparations for the course part, some students did not prefer to prepare the course before the class. In addition, reliance on teaching process in laboratory, some students did not prefer to study on course and to use the resources (N=2). One of the assistants (N=3) explained the reasons of students' usage behavior from this perspective:

> *Bu materyaller bizim bolum için yapıldı ama şey öğrencilerin bize bakış açısından kaynaklanıyor. Hani asistan bize nasıl olsa anlatır biz anlattırırız demelerinden kaynaklanıyor. Hani bizim ile alakalı bir durum bence. Daha doğrusu daha önceden süregelmiş bir şey (TA #5)*
>
> *These materials were made for our department, but that's because of the students' perceptions of us. That's because of thinking that the assistants tell in anyway, we have the assistants to tell. This situation is related with us. More precisely, it is something ever since (TA #5)*

4.1.4.3 Resource-related Factors

The first course-related barrier was about the OERs possible effects' on students' grades. Contrary to the extrinsic motivation part above, some students considered the OERs, which possibly did not have direct impact on grades (N=3). One of the students explained this situation below:

> *Gerçekten hanı deneyin üzerinde çok fazla olumlu etkisi olsa tabı ki acar bakarım lab skorumu etkilese yine bakarım mesela şöyle olsa quıze yönelik olsa ya da ne bilim raporu hazırlarken bana yardımcı olsa elbette bakarım (SMI #5)*
>
> *Really If it has a lot of positive effects on the experiment, I would look at it of course, If it has an effect on lab grade, again I would look over, for example, if it is associated with quizzes or if it helps me in preparing the report, I would look at it for sure (SMI #5)*

In consistent, while the OERs did not include theoretical information about the experiments and the assessment of the course was not relied on students' performance on experimental procedure, they seemed unnecessary to use for the laboratory course:

> *Ya OCW bana zaman kazandırıyor evet hani hangi kimyasalları kullanacağımı biliyorum tanıyorum hani bunu böyle yapacağım şöyle yapacağım bunları biliyorum ama bana bu sorular sorulmuyor quizde. Beni bu şekilde puanlandırmıyorsunuz ki hani deneyi kaç dk da bitirdim falan diye (SMI #3)*

> *Well, actually yes, OCW saves me time; like I know which chemical I should use; what to do, what not to do but they don't ask these in the exam. I am not graded this way like which experiment took how long and stuff (SMI #3)*

The second course-related barrier was the poor fit of the resources on students' needs and purposes for the course. Some students indicated that the resources did not provide dramatic changes to understand the content knowledge and procedure of the experiments (N=7). This problem defined as mainly related with the complexity of the experiments and ability to perform the experiments. Firstly, students argued that the complexity of the experiment affected the requirement of the resources (N=4). This argument was provided through the quote below:

> *1-2 kere girdim, çok sık değildi (Resource kullanımdan bahsediyor). Çünkü baktım deneyler karmaşık deneyler değildi. Ama karmaşık deneyler olsa, o entalpi deneyini bize çok anlatmışlardı zor diye, ben ondan önce baktım da o deney de zaten çok zor değilmiş. Birinci öncelik değil videoyu izlemek benim için. Çünkü dediğim gibi deneyler aslında, benim amacım daha rahat anlamak, öyle çok anlaşılması zor olmadığı için su ana kadar yaptıklarımız gerek duymadım (SME #18)*

> *I took a couple of times, not very often (talking about resource use), because the experiments were not very complicated. But even if the experiments were complicated- people told us that those enthalpy experiments were too hard, but I checked beforehand and found that they weren't that hard- watching the video is not my priority. Because, as I said before, the experiments are not very hard to understand, which my aim is to understand better, so I didn't need anything we've done so far (SME #18)*

Therefore, if they did not have the problems to understand the content and to implement the procedure, they did not need to search additional resources (N=3). A student focused on this behavior indicated in the quote below:

> *Yapamıyor olsam (deneylerden bahsediyor) mutlaka iste zaten 119'daki şeyim oydu hocadan anlamıyorum recitation dan anlamıyorum mutlaka bir yerden öğrenmem gerek o yüzden ek kaynağa ihtiyaç duydum, eğer simdi labda da böyle olsam çok zor olsa yapamıyor olsam lab skorumu etkileyecek kadar düşük olsa tabi ki yine ek kaynak arar bulurdum bunu ama… (SMI #5)*

> *If I weren't able to do (the experiments), which was the case in 119 in which I could neither understand my teacher nor recitation, I would definitely need extra resources. And now again if I have difficulty in the labs, if it is really*

hard, if it is so low that it effects my lab score, then I would look for and find extra resources… (SMI #5)

4.1.4.4 External Factors

One of the most mentioned barriers to use the resources was related with the information about the OERs. Some students complained not to be informed properly about them (especially in control group). (N=11). They mentioned that they could use the OERs if they had been informed at the beginning of the semester. One of them expressed his behavior as:

> *Geç haberim oldu. Haberim olduktan sonra kullanmaya başladım. Donem başında donem ortasındaki hatırlatma yapılsaydı ki yapılmış olabilir ben duymamış olabilirim. Yani yapılmadığını iddia etmiyorum, o zaman bakabilirdim. Sonraki deneyde bakmamamın sebebi make-up aldım. Daha önceden haberim olsaydı, bir kaç deneye daha girmiş olsam bakacağımdan eminim (SMI #8)*

> *I have just heard about it. I started using after I found out about it. If we were reminded at the beginning of the semester, which they may have and I may have not heard about it so I don't mean that they didn't, then I would check it out. The reason why I didn't check is that I got a make-up. If I had known earlier and I had done some more experiments, I am sure, I would check it out (SMI #8)*

Regarding the information and awareness issue, the questionnaire displayed significant results for the effects of awareness of students' usage profile. The effect of awareness on usage profile was calculated by chi-square and the result of this test reported that there was a significant association between the awareness and usage of the OERs χ^2 (1) = 74.69, $p < .001$. This significant result displayed that when the students were aware of the OERs, 56 % of them were used the resources for their courses whereas when the students were not aware of the OERs the usage was only 5.7%. Therefore, information related with the OERs was an important factor to increase the use of the OERs.

The second external factor was related with the comments of friends (social influence). This issue could be categorized either a motivator or a barrier to use the OERs (N=2).

Contrary to friends' incentive effect on usage behavior, some comments could change the perspectives negatively. A student mentioned her memory as:

> *Ya benim arkadaşım bana söylemişti siz ilk hafta sorduğunuzda ilk ya da ikinci hafta sorduğunuzda bana çok kotu demişti yani hani felaket bile değil falan yorum yapmıştı o etkiledi beni açıkçası o zaman bakmaya gerek yok diye düşünmüştüm (SMI #5)*
>
> *Yeah, my friend had told me about it when you asked the first or second week; s/he said it was very bad. It was more than terrible; I was actually imposed by her/him and so I thought it was useless to take a look (SMI #5)*

4.2 Adoption-Implementation Theme

For the second-sub research question, firstly, the teaching and learning activities in GCLC environment were provided under three parts: teaching, experimentation and assessment process. Through these parts, the problems in these processes and secondly, their relation with OERs were displayed under the integration of OERs into the system part. In GCLC environment, cookbook style of teaching method was followed. At the beginning of the class, students took a quiz for 5 minutes. Then, teaching assistants taught the theory and the procedure of the experiments and after this part, students began to apply the procedure of the experiments. At the end of the class, students have to write a report about the results of the experiments.

4.2.1 Teaching Process

The first process in GCLC environment referred to the teaching process, which included the teaching methods and strategies. Derived from the observations in the class, each teaching assistant was responsible for a group of students (varying from 5 to 15 students). Most of time each group of students had the same teaching assistant; in some cases, they could carry on the process with other teaching assistants. There were six blackboards in the classroom and teaching assistants provided the content knowledge within 10-15 min to their group of students.

During the observations and interviews, some arguments about the teaching process were raised. These arguments mainly focused on the problems in the teaching process, which was categorized under three sections in terms of teaching method, teaching styles of the teaching assistants, and interaction between the students and teaching assistants.

4.2.1.1 Teaching Method

Regarding first category, teaching method, faculty (teaching assistants and professors) had some concerns about the teaching in the main lecture and laboratory course. (N=4). They mentioned to have unsatisfactory teacher-directed experience that they did not have an active learning process. A professor indicated this concern as:

> *Bizim anlatımımız öyle değil maalesef (problem-tabanlı öğrenmeden bahsediyor). Biz standart. Veriyoruz, öğrenci geliyor kitabi açıyor. Birinci madde su, ikinci madde şöyle…Yani çok yaratıcılık getirmiyor maalesef. Hani diyoruz ya dersin syllabus unu yazarken öğrenci su duruma gelecektir diye. Bunlar başında tasarlanırsa ona yönelik öğrenci yetiştirilebilir. Ama bugüne kadar böyle bir şey yapmıyoruz. Elimizde bir textbook var, ondan sonra konuları anlatıyoruz. Arkasından bitiyor iste. Lab da da öyle, standart bir şey var. Yani o pasif eğitim (P #1)*

> *Unfortunately it is not our way of teaching (talking about broblem-based learning). Our system is standard. We give the material, students come and open the book and go on like "this is the first fact, that is the second…"I mean it's not very creative. You know, we write the objectives at the syllabus like the student will be able to do this and that. If all these are planned at the outset, we can train students in that direction. But we haven't done such a thing so far. We have a a textbook, and we just explain the topics. Then it is over. So is lab; it is fixed. That's passive education (P #1)*

As seen in the quote above, the teaching process mainly directed by the teaching assistants and the process did not provide much opportunity for students to interpret the activities. As mentioned before, the cookbook style of teaching, which mainly focused on the result-oriented learning activities leaded the students as passive learners in the course. One of the faculty members argued this issue and provided a suggestion to make the students active learners.

Yani ne olsa iyi olabilir? Öğrenciye biraz kendi yaratıcılığını da teşvik eden bir şekilde tasarlanabilirse. Yani laboratuvarlar genellikle bir prosedür veriliyor öğrenci geliyor onu uyguluyor. Yani çok pasif bir şey aslında. Mesela bir problem verilip al bununla ilgili bir araştırma yap, ne bileyim bir ölçüm sistemi falan olsa. Yani deney ona göre tasarlansa öğrenci böyle onları nasıl kullanacağını, iste bu materyalleri öğrenip gidip kendi kendine yapabilecek bir duruma, tabi ki asistan olacaktır başında yardımcı birisi ama böyle problem tabanlı öğrencinin biraz elindeki şeyleri bilecek potansiyel, iste laboratuvar kaynakları nedir onları bilecek, ne ise yaradıklarını oradan gidip bakabilecek ama onunla ilgili bir sistemi oturtup iste onunla ilgili sonuç alabilecek gibi tasarlansa çok güzel olur ama bu tabu ayrı bir felsefi yaklaşım tabi (P #1)

Well, how can it be developed? For example, the course can be designed to encourage the students to use their creativity. In the labs, the students are given a procedure, and they just put it to use. It is so passive honestly. If only the experiments were designed that way; the student knew how to use them, learned the materials enough to use them by themselves, of course with the assistance and control of the assistants, knew and checked what they have in hand, how they work, it would be really productive. But this is a totally different philosophical approach of course (P #1)

In GCLC environment, instructors determined every activity and students did not have a key role in the environment. They were observed to mostly focus on experimentation process but they generally aimed to finalize the process rather than to interpret the process in their own learning process. Therefore, different teaching styles (problem-solving, discovery learning) could be implemented to activate the students' learning process.

4.2.1.2 Teaching Styles

Regarding second category, all teaching assistants had different teaching styles even if they followed the exact procedure of the experiments. While some of them were focusing on the content knowledge and theory, some of them were eager to express the procedure of the experiments more. They typically began with the theory and continued with the procedure of the experiments. In order to explain the procedure, they usually draw pictures or write the formulas on blackboard. Related with teaching styles, some criticisms aroused during the interviews. The first mentioned issue was related with the differentiation between the teaching assistants (N=5). One of the students shared his experience as below:

> *Hocadan hocaya çok değiştiğini düşünüyorum. Geçen hafta bizim hocamız yoktu, başka bir hoca geldi ve gereksiz ayrıntıya girdiğini düşünüyorum. Kesinlikle doğru bilgi ama o an bizim işimize yarayan bir bilgi değil. Hem bizi labdan soğuttuğunu düşünüyorum açıkçası. Ders derste öğrenilir, lab labda yapılır diye düşünüyorum yani (SME #19)*

> *I believe it depends on the lecturer. Last week our lecturer wasn't here, so another one substituted. I think that s/he got into too much detail. Of course they were correct information but they were useless for our work. Plus, I honestly think that it caused us to take a dislike to the labs. I mean, I think lessons should be taken during the lessons and labs should be done in the labs (SME #19)*

In common with the students' experience above, one of the teaching assistants also criticized their teaching style (N=2) as:

> *Yani şöyle bu düzen bence fena değil, iyi ama dediğim gibi bazı insanlar teorik kısmını çok anlatmıyor, direk prosedüre geçiyor. Bazıları teori ile çok boğuyor. Belki o konuda bir yapılandırma olabilir. Sadece şunları anlatacaksınız biraz belki şey gerçi bu her dersin hocası farklıdır hani farklı anlatımları olur (TA #1)*

> *Well, actually this system is not very bad; it is good but as I said before, people don't mention the theoretical part much; they just go directly to the procedure. Or some of them give too much theoretical information. Maybe we could have some configuration about this. Like you just present this and that for example. Well, every teacher has his/her own style though (TA #1)*

The second issue about the teaching styles was about the quality of the teaching process. How the teaching assistants provided the purpose and logic was related with the assistants' content knowledge and background. Therefore, these characteristics of teaching assistants reflected the quality of the teaching process. One of the assistants criticized this issue as:

> Interviewer: *En azından öğrenci bu deneyi neden yapıyor, niçin yapıyor anlamında bir şey olabilirdi. Çünkü bu açıklamayı öğrenci nereden öğreniyor, yani bu deneyi neden yapıyorum…*

Interviewee: *İşte o biraz sıkıntılı. Bir asistanından öğrenebilir ama hani asistanının buna yönelik bir anlatım yapması lazım. O konuda her asistan yapıyor mudur yapmıyor mudur çünkü direkt öyle bir şeyimiz olmadığı için, standart bir anlatım prosedürümüz olmadığı için açıkçası bilmiyorum. O anki hani asistanın durumuna bağlı ve hani backgrounduna da bağlı açıkçası biraz. Hani o konuda biraz da şey yapması lazım, hani ne diyeyim olması sindirmiş olması lazım ki bunu nakledebilsin. O yüzden orada biraz şey vardır, boşluk olabiliyor. Her zaman yüzde yüz açıklayamıyoruz (TA #10)*

Interviewer: *At least that could be something about why the student does this experiment because how can a student learn about it. I mean why they do this experiment.*

Interviewee: *well, that's a bit problematic. They can learn from their assistants, but the assistants should make an explanation on that matter. I am actually not sure whether all the assistants make any explanations or not as we don't have a standard teaching procedure. It depends on the situation or background of the assistant there. S/he should, actually, absorbe it so s/he can transfer. That's why we have some failure here. We can't explain everything a hundred per cent (TA #10)*

In order to prevent this issue, the department began to apply a strategy to standardize the teaching process. They determined the scope of the content in order to minimize the differences between teaching styles.

Asistanlarımız iki hafta önce toplanıyor, o deneyin üzerinden hep beraber geçiliyor, ne anlatılacak ne anlatılmayacak konuluyor ortaya, herkes ayni şey, tabii ki anlatımda biraz farklılık oluyordur ama onu zaten bir şekilde iste standardize ediyoruz gibi bir şey düşünülebilir orada (P #2)

Our assistants come together two weeks earlier; they all go over that experiment and discuss what to teach, what not to teach. They all do the same thing although their style is different from each other. But we manage to standardize it somehow (P #2)

4.2.1.3 Interaction

During teaching process, as generally observed, the interaction between the students and the teaching assistants was at the minimum level. Most students seemed to follow the process but they were not eager to ask questions about the theory and procedure of the experiment. Thus, the interaction between the students and teaching assistants were not promising for a desirable teaching process (N=7). The lack of interaction between them could have some reasons to consider. One of the teaching assistants remarked one reason for this issue as:

> *Biz oraya çıkıp konu anlattığımızda her deney tek parttan oluşmuyor yani her deneyin baktıysanız eğer 3-4 parti var, 3-4 asamadan oluşuyor. Simdi ben oraya çıkıp bir şey anlatmaya başladığım zaman ilk part tamam full dikkatli ama yavaş, yavaş artık diğer aşamaları anlatmaya başladığım zaman o dikkat gidiyor. Ben onu görebiliyorum hani o dikkat dağınıklığını. Sonra ne oluyor o aşamalara gelince, burada ne yapıyoruz. Hani kitaba bakin diyorum. Kitaptakini anlayamadık seklinde cevaplar alıyorum (TA #2)*

> *When we explain it in the class, -you know every experiment consists of 3-4 phases, at the first phase the students are focused, but in coming phases students start losing attention. I can tell easily that students have lack of attention. Then I tell them to check the textbook, but they say they don't understand the explanations in the textbooks (TA #2)*

As the teaching assistant described a reason for the lack of interaction caused by long procedure of the experiments. Students could not preserve their attention until the end of the teaching process so that could decrease their interaction with the content and the assistant. The second reason for this issue was related with the need for the teaching process. Students had different ideas, which indicated the different interests for the course. The students with this profile had the purposes to implement the procedure as soon as possible (N=3). One of the students described his perception about this issue:

> *Hani mesela kendi adıma soyluyorum ben kimyayı çok seven birisi değilim asistanlar bazen çok hani sunu bilin diye uğraşıyorlar hani yani o yüzden o biraz da kişiye bağlı hani sonuçta mesela ben giriş quizlerinde çok doldurmuyorum ama açıkçası çok da etkilemiyor hani sevmediğim için dersi dolayısıyla o deneyi anlatım kısmında ders konusunu biraz daha azaltırlarsa ya da kaldırırlarsa daha iyi olabilir hani bunu sadece ben de değilim çoğu kişi vardır böyle (SMI #7)*

> *Well, for instance, personally I don't like chemistry much. The assistants insist that we learn this and that; well actually it depends on the student. For example I don't fill up many questions in the entrance quizzes but it doesn't effect anything much. You know I don't appreciate the lesson, so it would be better if the explanation of the experiment were simplified or omitted. And it's not only me who thinks that way (SMI #7)*

The student stated the quote above observed during six weeks that he generally did not listen and began to implement the procedure before the experimentation starts. Another observed students also showed similar behaviors that they did not need the teaching process to implement the procedure. A research assistant explained this behavior through the lack of assessment in the course:

> *Şöyle bir durum var, siz teoriyi anlatıyorsunuz deneyin başında tahtada, çoğu öğrenci dinlemiyor çünkü onu bağlayan bir durum yok, bundan sonra sınava girmeyecek, sadece o gün deneyini yapacak ve ondan puan alacak (TA #8)*
>
> *We have some cases like the teacher explains the theory on the board at the beginning of the experiment; but not many students pay attention because they are not supposed to learn the theory. They will not take any exams; they will just get a grade from the experiment that day (TA #8)*

As mentioned in the quote above, there was no assessment after the experimentation process except reports, which assess the student's content knowledge. However, most of the students considered the teaching process as a need for their learning process so they suggested preserving this process (N=18), while three of them determined the process as unnecessary. One of them pointed the issue as:

> *Bence bu sistem iyi (teaching process den bahsediyor) çünkü sen ne kadar hazırlanmış olsan da arada bir şey kaçırmış olabiliyorsun. Arada hocayı dinleyerek ha bu da vardı falan diyorsun (SMI #12)*
>
> *I suppose this system is good (about the teaching process) because however much you prepare beforehand, you may have missed something. And when you listen to the teacher you have the chance to catch up (SMI #12)*

4.2.2 Experimentation Process

After the teaching process, students began to implement the procedure of the experiments. Firstly, they gathered the required equipment, and then they sat up the experiments. Two students worked collaboratively during the experimentation, they mutually sat up, managed and implemented the experiments. They were free to use their laboratory book but they were not allowed to use mobile phones in any case. In each bench, two groups of students worked and interacted with each other and the students in other benches. Teaching assistants also walked round the benches in order to help the students. In the next sections, the problems in the experimentations process were provided under four issues.

4.2.2.1 Result-oriented Learning Experience

The most mentioned issue related with the experimentation process was the teacher-directed and result-oriented experience during the experimentation. Each three groups had some concerns about the students' learning activities, which mostly described as *meaningless, robotic* or *unsatisfactory* (N_s=6, N_{ta}=4, N_p=4). One of the students explained his experience through this perspective;

> *Genel olarak labla ilgili bu eleştirim, genel olarak bize şey deniliyor, şunu şunu şöyle yap, şunu şöyle yap, sonucunda bu olacak. Olacak da arada olan işlem ne, neden ben bunu buraya katıyorum, yani o işin biraz neden kısmında, yani neden yaptığımız kısmında biraz eksiklik var bence. Genel kimya labı olarak konuşuyorum. Onun için kimyasalları ben ne kullandım, ne ettik şimdi çok aklımda kalmadı. Çünkü dediğim gibi neden yaptığımı bilmediğim için, hani bana dendiği gibi yaptığım için o konuda biraz sıkıntı oluyor gerçekten (SMI #19)*
>
> *In general, about the labs, they tell us to do something in this way or that way, and this will happen eventually. However, what happens in between? Why do I add this here? I mean there are some flaws about the reasons why we do something. Again, I am talking about the general chemistry labs. So I don't remember which chemicals I used, what I did with them. So as I said now, I don't know why I do it, I just do what they say. That creates a big problem (SMI #19)*

While the faculty members mostly (N=4) criticized the students' studying behaviors and lack of interest for the course, two of them discussed this problem from their teaching abilities and activities beside the students' behaviors:

> *Zaten en büyük sıkıntılardan birisi o deneylerde büyük sınıflarda daha çok oluyor aslında o. Hani bir yerden sonra motomot iste alıyorsun, karıştırıyorsun, yapıyorsun sonuç odaklı çalışıyor ama hani aslında onun arkasında amaç var. O amaca çok yoğunlaşamıyor öğrenci. İşte ders temposundan bir an önce bitireyim gideyim, başka şeylerle uğraşayım temposundan o konuda biraz özel caba sarf etmek gerekiyor bence. Hani cok basit değil çünkü neyi, niçin, neden yapıyoruzu verebilmek. Onun için bu yönde*

kafa yormak lazım. Eğitimciler olarak biz de belki bu yönde zayıfiz. Dolayısıyla öğrenci de o konuda zayıf (TA #10)

Well, that's mostly one of the biggest problems in bigger classes during the experiments. After a while, you start thinking automatically; just mix the substance, do the experiment… You just focus on the result. But there is actually a goal behind it. The student cannot focus on that goal. You know, they just aim to pass and occupy themselves with other stuff. So, I believe we need to make some more effort on it. It's not very easy to show the student why we do something. That's why we have to meditate on this. Maybe we educaters are weak about this. Thus, so are the studends (TA #10)

4.2.2.2 Role of the Teaching Assistants

Related with the teaching process, teaching assistants had the primary responsibility to teach the content knowledge and to guide the students during the procedure of the experiments but some changes needed to apply in the experimentation process (N=3). One of the teaching assistants described her desired position in the classroom as:

Biraz teoriden bahsedip biraz prosedürden bahsetmek ve asil amaçlarının ne olduğunu anlatmak bence önemli. Hani bunları asistan bir şekilde anlattıktan sonra ve deneye de aslında çok karışmamamız gerekiyor. Çünkü onların hem yaratıcılık duygularının gelişmesi gerekiyor hem de biraz kendi başlarına prosedürü okudukları zaman ne anlıyorlar o olması lazım ama maalesef biz biraz fazla karışıyoruz (TA #1)

I think that it is important to explain not only the theory and procedure but also their main aims. Like, after the assistant explains them, we shouldn't interfere in the experiment because they need to improve their creativity and understand the procedure when they read it by themselves. But unfortunately we interfere in a bit too much (TA #1)

As mentioned in the quotation above, teaching assistants played a key role on students' learning activities. In GCLC environment, teaching assistants mostly answered the questions because they wanted to help their experimentation process. In addition, they mostly gave the exact answers for the questions instead of providing guidance to find the answers. However, this approach reinforced the students' asking behaviors. Most of the teaching assistants were aware of this problem and they mostly wanted to support the students' interpretation process but the time and number of students restrained their desirable behavior.

4.2.2.3 Excessive Number of Questions

During the observations, excessive number of questions was observed and was defined as the most remarkable problem. During the experimentation, except small number of groups, students tended to ask questions about every detail in the procedure (N=8). One of the students clarified this issue with his reasons:

> *Bir hatırlayamama, iki fazla garantici olma çünkü bir yerde hata yaparsam tekrar bastan başlayacağımı biliyorum. O riski almayı göze alamıyorum. O yüzden sürekli asistanlara soruyorum. Bence asistan sayısı fazla olması çok iyi, fizik labimizi mesela tek ya da iki asistan ile devam ettiriyoruz. Orada soru cevap kısmı bayağı sıkıntılı geçiyor ama kimyada ben nereyi kafamı cevirsem bir tane asistan gördüğüm için süreç aksamıyor (SMI #8)*

> *First, not remembering, second not taking enough risks, because if I make a mistake, I will have to start all the way from the beginning. I am not brave enough to take that risk. That's why I always ask the assistants. I think it is good that the number of the assistants is high. Our physics lab, for instance, is maintained by one or two assistants. There, the question-answer part is a bit problematic. But in chemistry lab, as there are assistants everywhere, the process does not fail (SMI #8)*

On the other hand, one of the teaching assistants portrays this issue from their side of view. The main problem about the excessive number of questions derived from the lack of preparation and lack of interest for the course.

> *Aslında daha önceden söylediğim gibi hiç bilmeden gelmek ile, genelde çok çalışarak gelmiyorlar hani quizler de çok zor olmuyor. Çok da zorlayıcı değil zaten. Bir şekilde üzerinden geçip geliyorlar sadece ama sonra da biz şey oluyoruz ayaklı prosedür oluyoruz yani. En bastan bir anlatıyorsun ama hiç çok çalışmadan geldikleri zaman algılayamıyorlar, gözlerinde canlandıramıyorlar. Ondan sonra tek tek her birisi her adimi soruyor. Cok ilgilenmediğin zaman, kendi başlarının çaresine bakmayı biliyorlar aslında onu da fark ettim (TA #6)*

> *In fact, as I said before, they don't go over the topic before the lesson much, and also the quizzes are not very hard. They somehow check out the lesson a bit but we are like walking procedures. We explain at first but if they haven't studied the topic beforehand, they cannot understand; they can't visualize. Then they all ask each step. But I realized that when I don't interfere much, they learn how to deal with themselves somehow (TA #6)*

Related with this issue, as mentioned in the preparations for the course part, the students mostly relied on their teaching assistants' support during the experimentation. Therefore, the role of the assistants negatively affected the students' behavior. This issue was also inferred from another observed problem: the quality of the questions. Most of the students asked questions in order to learn the next step in the process rather than to understand the purpose of the experiments. One of the teaching assistants shared her experience below:

> *Genel olarak genel kimya laboratuvarında öğrenciler deneye yönelik çalıştığı için hani zaten biz laboratuvardayken de gelip bize sürekli prosedür soruyorlar. Yani gelip de şu neden oldu diyen çok az öğrenci var, onlar da ilgili öğrenciler. Biz zaten deneyin başında anlatmaya çalışıyoruz teorik kısmı, püf noktalarını, neredenin önemli olduğunu vurguluyoruz ama öğrenciler genellikle prosedürüyle ilgileniyorlar. Deneyi yapayım bitireyim mantığında çoğu mühendislik öğrencisi çok fazla ilgi alanlarına koymuyorlar galiba (TA #11)*
>
> *Generally in chemistry labs, the students study experiment-oriented, so they always ask us questions about the procedures when we are at the labs. I mean there are few students who ask why this or that happened and those are really devoted ones. We already try to give them the theoretical parts, tips and what is important but they are more concerned with the procedure. Many engineering students who want to finish the experiment and go are not very concerned I guess (TA #11)*

In this situation, like the problems in the teaching process, the interest for the course also affected the quality of the experimentation process of the students. Less interested students mainly focused on the experimentation process rather than the content knowledge in teaching process, which was supported by the findings in the teaching process.

4.2.2.4 Excessive Number of Students

The third observed problem in the experimentation process was the number of students. Two groups were observed during two semesters and for example, METE group (39 students) was more quiet and having more comfortable learning environment than MINE group (61 students) in the first semester. One of the assistants (N=5) mentioned this problem as:

> *Bu donem biraz rahattık her labda çok fazla asistan vardı. Şey yani herkese çok güzel miktarlarda kişi başına öğrenci geldiği için hepsine evet yeterli olabildik ama mesela gecen donem fazla öğrencim oluyordu. O zaman herkese yetişmeye çalışıyordum ben elimden geldiğince (TA #2)*
>
> *We were fine this term as there were a lot of assistants in each lab. We were efficient as we had enough assistants for the number of students but I had too many students last term. I was making too much effort to deal with each student then (TA #2)*

This problem could negatively affect the teaching assistants' performance and guidance during the experimentation. The department applied a strategy to eliminate the problem by dividing the departments into groups, still many departments had to take the course in excessive numbers (like mechanical, civil, mine engineering departments).

4.2.3 Assessment Process

Assessment process began with the quizzes at the beginning of the course. These pre-quizzes took five minutes to complete. Then at the end of the course, students were required to write a report about the results of the experiments.

4.2.3.1 Pre-quizzes

There were different arguments about the pre-quizzes which students and teaching assistants took different positions in this issue. Some students criticized the quality of the questions in the quizzes as not to evaluate the learning properly (N=5). A student explained the problem as follows:

> *Bir önceki quizimizden mesela yola çıkayım. Kitabi falan da okudum, çalışıyorum, çalışmaya çalışıyorum, çalıştım ve girdim o quize. Ama çalışmadığım yerlerden gelmiş ve sebebi hani…. Ve anlıyorsunuz ki bu lab bununla ilgili. Tamam hepsine hazırlanıyorsunuz, ben artık bunu yapmayı biliyorum, sebeplerini biliyorum, neden bunu yaptığımızı biliyorum ama hiç bakmadığımız temel bir yerden bir şey çıkıyor. Bilmesem de olur, çünkü zaten*

ben bu sureci nasıl yapacağımı öğrenmişim, neyin nerede olacağını biliyorum ama orada bir isim soruyor (SME #16)

Take my previous exam for example. I had read the textbook; I had studied and finally took the exam. But the questions were from the parts that I hadn't studied; so you understand that is what the labs are for. OK, I am prepared for everything, I know now how to do this and that, I know the reasons, I know why we do these but I just encounter something basic unexpectedly. I don't have to know it, because I already know how to maintain the process but there is question about a name in the exam (SME #16)

In addition to this problem, the students were familiar with the possible questions in the quizzes, which could lead them to memorize the information (N=3). One of the teaching assistants evaluated the quizzes based on this perspective:

Sorular ezber. İşte oradaki boşluğu doldur. Kitaptaki cümlenin aynisi. Yani hani oraya çocuk ne yazsa olur mesela. Boşluk doldurma sorularının bazıları gerçekten kötü. Hani onu ben iki senedir fark ediyorum. Ne bileyim yani biraz daha hani çocuğu yönlendirebilecek bir şey olmalı ya da ne bileyim bir bu klasik soru sorulabilir. Hani bu konu hakkında açıklama yap ya da deneyde yapacağı şeyi okuyup geldiyse hani deneyse şöyle bir şey olduğunda ne bekliyorsun gibi, bana şu tepkimeyi yaz ama hani çocuk kafadan atarak yazmaya çalışıyor. Ben böyle bir şey gördüydüm potasyum vardı da yanındaki neydi. Şişelere bakıyor. Hani yazık hani çocuğa da yazık. Bir şey öğrensin de gitsin bari. Geliyor altı hafta boyunca ezberleyip gitmesin (TA #9)

The questions are parrot-fashion. Like fill in the blanks; they just copy and paste the sentence from the textbook. I mean what can a student possibly write there? Some of the fill-in-the-blanks questions are really bad. I am aware of this for the past two years. We must have something to canalize the student, like we can ask open-questions such as "explain this subject" or if it's an experiment, "what do you expect in this situation?" or "explain this reaction". But in this case the student tries to make it up like "I saw something like this before, it's probably potassium but what is the other thing?". They give a blank look at the flasks. I feel sorry for them too. They should at least learn something for six weeks, not just memorize (TA #9)

The questions in the quizzes were mainly created based on laboratory book. Some students explained that they only looked and memorized the bold or underlined sentences in theory and procedure parts. Therefore, they basically studied for quizzes rather than the experimentation process. Therefore, if the questions were designed to made students to interpret the process, it could be more valuable for students.

The quality problem also leaded the department to create a question poll to standardize the questions. Therefore, 20-30 questions were created for each experiment. A research assistant explained the strategy for the standardization to make the process easier for them.

> *Quizler eskiden biraz daha serbestti, isteyen istediği şekilde sorabiliyordu. Sonra bir soru bankası oluşturuldu, şu an standart bir soru bankamız var. İçinde 20-30 her deney için quizler var, sorular var onların içinden seçiyor asistanlar dolayısıyla artık daha standart en azından hocalar bunu gördü, asistanlar gördü, elden geçti. Çok sıra dışı bir şey yok quizlerde gördüğümüz kadarıyla zaten, çok şey olduğunu düşünmüyorum seviye olarak çok ağır olduklarını düşünmüyorum açıkçası. Ya zaten sorular belli, deneyin amacı nedir diye sorulan sorular bile var. Temel olarak öğrenci okumuş mu, deney hakkında fikir sahibi mi ona yönelik quizler (TA #10)*

> *The quizzes used to be more flexible; the teachers could ask whichever question they wanted. Then, a question bank has been created. Now we have a standard question bank with 20-30 quizzes for each experiment. The assistants pick up questions from the bank, so now our quizzes are more standardized. At least the teachers and assistants have seen and reviewed them. There are not many extra-ordinary questions as I observed, and I don't think they are too hard for the students' level actually. The questions are obvious; there are even questions asking for the aim of the experiments. They basicly aim to check if the student has read the textbook, if they have any idea about the experiment or not (TA #10)*

The second argument about the quizzes was related with the sequence of the quizzes (N=5). As mentioned in the preparations for the course and teaching methods part, some students had a studying style oriented by quizzes. After the quiz part, they could lost their attention for the course. Related with this issue, most of the students suggested providing post-quizzes rather than pre-quizzes. One of the students expressed his preference in the following quote:

> *Yani belki giriş quizi yerine çıkışta quiz yapılması daha mantıklı olur. Bu sefer tam anlamıyla deneyi de kavrıyoruz. Çünkü önce gelen sorular genelde biraz da deneyle ilgili oluyor hani deneyi uygulamalı olarak yapmadan cok fazla bir bilgi sahibi olamıyorsun. Bence çıkış quizi yapılırsa çok daha faydalı olabilir. Mesela çıkışta artık quiz olmadığı için biraz boşlayabiliyor deneyi (SMI #13)*

> *Well, maybe it would be better to evaluate the student at the end rather than the beginning, because the questions that are asked at first are about the experiment, and students don't have much information before they carry out the experiment. So I think a final quiz would be more beneficial, because otherwise the student may lay down on the experiment thinking there is no more quiz (SMI #13)*

From the teaching assistants perspective there were contradictory ideas about the sequence of quizzes. One of the research assistants explained this issue from his experience:

> *Bu hep zaten tartışılan bir şey asistanlar arasında bu quizi yapmalı mı yapmamalı mı, dersin başında mı yapmalı sonunda mı yapmalı her çeşidini denedim ben çeşitli laboratuvarlarda. Hepsinin kendisine göre getirisi var, götürüsü var. Quizi başta yaparsanız öğrenci zoraki de olsa çalışıyor, çalışmak zorunda kalıyor. Dolayısıyla deney hakkında bilgi sahibi oluyor, size daha az iş düşüyor, o açıdan bir yararı oluyor. Ama quizi sonda yaparsanız da deneyi yapıp anladığı için başta belki anlamadığı için orada çözümleyip kendi kafasında oturttuğu için onu yansıtabilme imkanı oluyor öğrencinin öyle bir avantajı oluyor. Dediğim gibi ikisinin de avantajı var, dezavantajı da var. Bilmiyorum ideal bir sistem bulamadık bugüne kadar (TA #10)*
>
> *It has always been controversial among the assistants to do the quiz, if we should do it at the beginning of the lesson or at the end. I have tried every way in various labs. They all have adventages and disadvantages. If you do the quiz at the beginning, the student is obliged to study. That's how they gain some information about the experiment and thus you have fewer jobs to do. It is beneficial that way. However, if you do the quiz at the end, the student has the opportunity to reflect what they have learned because they have carried out the experiment and learned what they hadn't understood before the experiment. So they have this advantage. As I said they both have adventages and disadvantages. I don't know, we haven't managed to find a suitable system so far (TA #10)*

Hence, the quizzes in the course were mainly a problematic issue based on the quality of the questions and the sequence of them. The community in the department (faculty and teaching assistants) determined this procedure for the quizzes but the clients in the course (teaching assistants and students) mainly had some hesitant and concerned ideas about this process.

4.2.3.2 Reports

The second major step in the assessment part was writing reports. Students were required to write a report at the end of the class. Derived from the observations, all of the students gathered outside of the classroom and completed the reports in cooperation. However, they needed to complete their reports in one hour but they did not have a comfortable place to discuss and write their reports.

The second observed problem was that while the cooperation between the groups was considered as an effective learning process, the cooperation in this situation was used for completing the report by the help of other classmates. Therefore, this situation brought the problem for the validity of the personal evaluation (N=3). One of the students highlighted this problem as:

> *Değerlendirme nasıl yapılıyor o konuda çok fazla bilgim yok çünkü herkes zaten beraber yapıp birbirinden falan böyle baktığı için bilmiyorum gerçekten çok doğru mu doğru bir değerlendirme mı ya da mesela lab raporu o kadar puanı hak ediyor mu o konuda çok şey emin değilim (SME #9)*
>
> *I don't have much information about evaluation because everybody does the experiment together and copy each other. So I am not sure if this is an accurate evaluation or the lab report really deserves such points (SME #9)*

Similarly, this problem was also valid for the experimentation process. In the course environment, the department divided students into groups with two people who worked collaboratively during the experimentation process. However, some groups were observed that one of the students in a group mainly implemented all the process but they were evaluated equally in their performance for the experimentation process because they did the same experiment and took the same results of the experiment. Moreover, the excessive number of students also brought some difficulty to evaluate the individual performance in the experimentation process.

The last problem about the reports was the quality of the questions in the reports. Some participants argued that the reports did not support interpretation about the content knowledge (N=3). A student focused on this argument and provided a suggestion on this issue:

> *Aslında raporlar yanı biraz şey hocam ya ne bilim gereksiz gibi duruyor bazı şeyleri çünkü ıı orda mesela kitabın bize sorduğu şekilde yanı deneyi o şekilde ifade etmek istemiyoruz mesela bazen iste yaz diyor ha biz burada kimya deneyi yapıyoruz orda bize işte evaluate et diyor sunu yap sunu yap biz burada bayağı bir uğraşıyoruz ama aslında onun yerine orda mesela hep bos bıraktığımız explaın kısmı var ya yanı düşündüğümüz orda mesela şöyle oldu falan gibi bunu açıklasak hanı böyle olmasını bekliyoruz hanı bizimki buna yakın oldu falan diye açıklasaydık bence biz daha yanı o deneyi daha çok anladığımızı fark ederdik (SME #5)*

> *Actually the reports are a bit unnecessary if you ask me, because we don't want to express the experiment the way they are asked in the book. For example, we are asked to evaluate in the exam while we do a chemical experiment there. We work hard on the experiment, so it would be better if we were asked to explain what happened, what we had expected and what our experiment resulted in, then we would evaluate if we understood the experiment or not (SME #5)*

Therefore, both quiz and reports mainly criticized by the quality of the questions and the application method.

4.2.4 External Factors

Beside the problems in the system through three processes, also some external factors affected the quality of the system. The first problem defined was non-parallel main and laboratory course periods. For department, it was difficult to arrange each lab after the main course period so that the contents in each week of the courses were different from each other (N_s=3, N_p=6). Thus, the students had some difficulty to associate the theoretical knowledge with the experiments in the laboratory. For this problem, at the beginning of the laboratory course, teaching assistants mentioned the theoretical knowledge to help students to memorize. However, this situation did not provide a sufficient solution for this problem. One of the faculty members stated this problem as:

Bizim evet genel kimyada, organik kimyada da sıkıntı evet yani çünkü biz mesela daha elektrokimyayı anlatmadan mesela işte onlar elektrokimya deneyini yapmış oluyorlar. Daha entalpi demeden onlar orada entalpi deneyi yapıyorlar ama şöyle yani aslında ideal yol evet derste görüp ondan sonra şey yapmaları ama laboratuvarın basitliğini düşününce de çok büyük bu ne ya, bu ne biçim şey, daha derste de görmedik gibi bir sıkıntı da olmuyor (P #3)

Well yes, we have problems in general chemistry and organic chemistry, because they have done the electrochemistry experiment before we explain electrochemistry. Before we teach the word enthalpy, they have completed enthalpy experiment there. But what's ideal is that they learn and then do the experiment. When the simplicity of the lab is considered, the students don't complain about anything like "this is too big, we haven't even been taught about it (P #3)

The second problem observed in the system was the frequency of the laboratory course (N=3). Each department took the course in two weeks period for three hours so that some students were not accustomed to the course. One of the teaching assistants mentioned this problem in his quote below:

Öğrenci laba çok ısınamıyor çünkü iki haftada bir geliyor. İki haftada bir geldiği için iki hafta öncesinde neydi, şimdi neydi hani beni bile hatırlamıyor çoğu zaman öğrenciler. Asistanı bile hatırlamayabiliyor ki oradan bir şey öğrenip bunu derse şey yapabilmesi, adapte edebilmesi için öğrencinin ekstra efor sarf etmesi lazım. O konuda çok iyi değil maalesef (TA #10)

The students don't get accustomed to the labs as they come one or two times a week. So, they don't remember how it was like two weeks earlier, and how it is like now. They don't even remember the assistant or me. The students have to give a big effort in order to learn something there and adapt it to the lesson. Unfortunately, it is not very effective in this matter (TA #10)

4.2.5 Integration of the OERs into the System

The OERs in this course were optional to use and they were not provided as a main instructional material for the course. Thus, this situation could bring some problems for the use of them. One of the students highlighted this issue from his perspective as below:

Bu sistem hanı şey olmalı hanı alışkanlık gibi direk böyle laboratuvarın ilk günü hanı kurallar söyleniyor ya o sırada bu sistemi de kullanıyoruz *arkadaşlar denip de hanı bunu laboratuvarın parçası yapmak bence çok güzel olur şu an biraz dışarıda kalıyor (SME #4)*

This system should be like a tradition. You know, the rules are listed on the first day of the lab. We should, I think, show them that we also use this system and make it a part of the lab. But it's a bit outside the system (SME #4)

Regarding this issue, one of the faculty members suggested a strategy to integrate the OERs into the system like flipped classroom approach (N_p=3). The resources with laboratory book could provide background information for the experiments and they could decrease the teaching process in the course environment.

Ama biz şunu dersek yani bunu öğrenmezsen laboratuvara giremezsin, quizi aldım mesela, geçemedin, giremezsin yani biz onu bire bir, yüz yüze yapılan bir eğitimle sağlıyoruz. Asistan geliyor işte üç saat öğrenciyle çalışıyor. Ona belki gerek kalmayabilir yani. Deriz ki git oradan öğren, deneyin simülasyonu var, git yap, ondan sonra onunla ilgili de sınavını al, geçersen laboratuvarda gerçek deneyi yapabilirsin. Yanı bu açıdan da faydalı olabilir (P #1)

But take that we say to them that they can't enter the lab if they don't learn this. For example, you take the quiz and you fail. So you cannot enter the lab. We provide it with face-to-face training. The assistants work with the students for three hours, and it even may not be very necessary. We can tell the student to learn from the simulation of the experiment and take the related exam. Then they can carry out the real experiment in the lab once they pass that exam (P #1)

Related with the suggestion above, the department began to apply a new strategy for the teaching process. They removed the teaching process for some laboratory courses so that students were required to find all the resources and to take studying responsibility for the course. In the course environment, only the experimentation process was being applied. Therefore, the quality of the resources became more important for the students. Related with this approach, a faculty member explained the reason for this practice:

Bizdeki eğitim sistemimizdeki yanlışlardan bir tanesi öğrencimizin derste her şeyin anlatılmasını beklemesi, yani bütün adımlarıyla. Böyle bir eğitim sisteminden geliyor derse geldiği zaman da bunu bekliyor. Öğrencinin bana labda anlatılacak, iste ben zaten asistana sorunca bana söyleyecek, simdi ne yapacağım cevaplarını almak yerine öğrencinin hazır gelmesi. Bunu da *kitabiydi, internet kaynaklarıydı diğer verdiğimiz bir sürü artı kitap var onların incelenmesiydi falan gibi yapmasını bekliyoruz (P #2)*

One of our educational system's flaws is that the students expect the teacher to explain every single detail with all steps. They come from such a system and expect it from our lesson, too. But what we expect from the student is to come to the lessons well prepared with the books, online sources or the extra books we assign them with rather than asking what to do in the lab (P #2)

Within this practice, the diversity and quality of the OERs became more important for laboratory courses. In addition, they also aimed to made students to take studying responsibility in laboratory courses but through the same practices in laboratory environment, the students' role as an active learner was still controversial. For GCLC environment, this practice had not been applied to General Chemistry Course which students mainly had problems about the quality of the instructional resources.

4.2.5.1 Integration of the OERs into Teaching Process

The different ideas about the need for the teaching process also brought new ideas and approaches to implement. Regarding especially the teaching process, how the OERs could be adapted to the course environment revealed many different ideas. While some participants offered to use the OERs (especially show the videos) instead of the assistants teaching process (N_s=7, N_{ta}=9), some participants supported to continue with the teaching process with the assistants as mentioned in the interaction category (N_s=11, N_p=2). The supporters' main concerns about that adaptation were related with the interaction, students' behaviors, the role of the teachers and technical inadequacy. One of the students expressed his concern related with the interaction:

Ders anlatımı yerine videoyu istemem açıkçası çünkü hocalar ders anlatırken üzerinden yeniden geçiyorlar ve takıldığım yerde direk soru sorabiliyorum. Videoda bu opsiyon yok (SMI #17)

Well, honestly I don't appreciate using videos instead of lessons because in the lessons teachers may review the topics while they give lecture and I can ask questions immediately. There is no such option in the videos (SMI #17)

The faculty member also mentioned his concern about potential effect of this adaptation on students' preparation as below:

> *Yani daha önce galiba toplantıda biraz konuşulmuştu. İşte ders laboratuvarda projeksiyonda o sırada iste videonun görüntüsü…Bana böyle biraz tuhaf geliyor. Yani öncesinde hazırlanmak için kullanılmalı ama lab sırasında sadece lab olmalı gibi geliyor bana. Yani o biraz şeyi engeller gibi belki öncesinde izleyim geleyimi engeller gibi bir açıdan. Oraya gidince iste asistan anlatacak, orada video dönecek, bu sefer öncesine hiçbir şey kalmayacak (P #3)*
>
> *I guess it was discussed in the meeting before. The video seems awkward to me in the lesson. Ok, it may be used for preparation, but for me only labs should be used during the lab. I think it may prevent the student from coming to the class having watched and prepared for the lesson. The assistant will give the lecture; the video will play at the background, so the student will have nothing to do before the lesson (P #3)*

Another concern about this adaptation was the role of the teaching assistant. Changing the teaching process with the OERs could negatively affect the teaching assistants' authority and respect in the environment. A faculty member remarked his concern about this issue as:

> *Yani ben asistanın devre dışı bırakılması taraftarı değilim, laboratuvarda asistanın yani demin konuştuğumuz o şeye geliyoruz hani bireysel etkileşim hani ben bunun da öğrenmenin bir parçası olduğunu düşündüğüm için asistanın devrede olması taraftarıyım. Hatta o donuyorken belki de asistan anlatabilir oradakilere. Yani o tarz bir şey olmalı ki asistanın orada otorite olduğu ortada olmalı yoksa zaten lab kontrolü biraz sıkıntılı olur. Artı asistanın bildiğini ve o konuya hakim olduğunu gösterir olması lazım ki saygı kazansın (P #2)*
>
> *I am not in favor of the idea that the assistant be deactivated. I believe that the assistant should be in the process because as I said before, interaction is the part of the learning process. I even believe that during the lesson, the assistant can teach the students there. I mean it must be obvious that the assistant is the authority in the lab; otherwise the control of the lab can be hard. Plus, the assistant should show that s/he is the master of that topic so that s/he can gain prestige (P #2)*

The last concern on the adaptation process was about technical infrastructures. In order to provide the OERs in the classroom environment, the department required some technical support from the institution. In addition to that, how to organize them in the lab environment was an obscure to apply.

> *Normalde 50 kişinin on tarafa toplanıp da video izlemesini istemeyiz, çünkü videoyu arkadaki izlemez. Su anda 50 kişiye tahtada anlatmaktan bir farkı yok onun. O yüzden farklı bir yöntemle yapılması gerekebilir, onu nasıl yapabiliriz bilmiyorum. Onu bir belki kendimiz deneriz. Ne olur ne olmaz bir görüp ona göre hareket edebiliriz. Hani bu uygulamada bize bir öneri getirebilirseniz ama rektörlük bize bir laba 6 tane projeksiyon vermeyecektir (P #2)*

> *Normally we don't want 50 students to gather up and watch a video because those in the back rows may not follow the video. It has no difference from giving a lecture on the board to 50 students. That's why we may show the video in different ways although I don't know how. We may try it out by ourselves and act accordingly after we see the outcomes. Well, you may suggest us something but I don't think the presidency can provide us with 6 projectors for each lab (P #2)*

On the other hand, rest of the participants especially the teaching assistants had positive feelings about the use of OERs on teaching process rather. One of the teaching assistants explained her desired strategy for teaching process as:

> *Bence en ideal çözüm asistanlar konuyu anlatırken bir yandan onlara gösteriliyor olması. Kontrollü bir bicimde. Hem asistanın isini çok daha fazla kolaylaştırır, hem de önemli noktaların altını çizer, hem durdurur teoriyi prosedürün içine gömmüş olur bence çok daha efektif olacağını düşünüyorum (TA #8)*

> *I believe the best solution is that the videos be shown in the background while the assistants are lecturing the topic, of course in a controlled manner. It not only facilitates the assistant's work, but also it gives the assistant the opportunity to underline important parts and pause the video to integrate the theory into the procedure. I believe that this will be much more effective (TA #8)*

As seen in the quote, the teaching assistants preferred to combine their teaching process with videos to show the experimentation process effectively. Because of the resources did not contain theoretical knowledge about the experiments, they would support to show the experimentation part in the teaching process. Therefore, this strategy could help the assistants' step-by-step expression of experimentation process.

4.2.5.2 Integration to the Assessment System

As mentioned in the use section, the OERs did not have a direct effect on assessment types in the system but quizzes and reports constituted one of the major motivations for the use of the OERs. Thus, some participants offered to modify the content in the OERs appropriate for the quizzes. A student clarified this statement as:

> *Onu biraz daha zorunlu kılmaktan ziyade hani Open Course 'da quizdeki soruların Open Course' dan çıkabileceği hani* biraz daha ittirme gücü ile *insanları alıştırmak biraz daha yapılabilir. Mesela şey anda bize nasıl üst sınıflar laba gitmeden önce labın o şeyini okuyup ondan çıkarıyorsa, burada da Open Course' dan çıkarılacağı o algı oluşturursa, algıyla alakalı sonuç olarak yani (SMI #9)*
>
> *Rather than making it obligatory, we can get people accustomed to the fact that the questions in the Open Course quiz will be from Open Course. For example, we can create an assumption that the questions will be from Open Course just like the senior students infer from the lab book before going to the lab; it's all about perception (SMI #9)*

Therefore, the OERs did not have an accepted place in the system. They did not used and adapted properly into the system so that they remained an additional practice, which nobody interested.

4.3 Policy Theme

For the third sub-research question in this study, in order to understand the system as a whole, the policy practices were analyzed under three sections; OER culture, departmental support and desired strategies/practices.

4.3.1 OER culture

4.3.1.1 User Culture

In this section, the participants' awareness and experiences with OER and METU OCW website were provided.

4.3.1.1.1 Beware of OER

Between 38 participants (students), 27 of them used any kind of open educational resources. For the teaching assistants, all of them (N=11) used open educational resources for their own learning process through their student process, only one assistant mentioned to use these kinds of resources for teaching profession. She used some videos, which showed some experimentation to get some inspiration for teaching process. The most popular website was MIT OCW but some students also used Yale and Duke University's OCW websites. In addition, some students used many resources from different universities and personal websites especially for calculus and physics courses. Moreover, the resources were from foreign websites but only one student mentioned that she used some Turkish resources from Yıldız Technical University and Istanbul Technical University. Other 26 users were not aware of Turkish university's OCW websites.

The participants were aware of the resources through friends, social media, family or their own search in the websites. These websites were university's own OCW websites, YouTube channels or ITunesU platforms. One of the students who used Turkish university's resources focused on why she preferred to use open educational resources:

> *Özellikle fiziği daha geç anlayabildiğim için oradaki anlatım, bir de Türkçeydi Yıldız Teknik'teki anlatım, bana daha çok faydalı oldu. Çünkü okulun kitabını okuyunca, yani fizik kitabına bakınca bazen bir şey anlamıyorum. Türkçe bir şeye ihtiyaç duyduğum zaman da internette yeterli kaynak yok bence. En azından üniversite düzeyinde yok. O yüzden çok yardımcı oldu (SME #15)*
>
> *Especially I have difficulty to understand physics, the expression there and the expression was in Turkish in Yıldız Teknik that was more useful to me. Because when I read the lab book, so when I look at the physics book, sometimes I do not understand anything. There are not enough resources on the internet when I need something in Turkish. At least not at university level. So that it helped me a lot (SME #15)*

As mentioned in use and performance outcomes sections, Turkish resources played an important role for students to understand the content in which most of the students suffered from the insufficient resources in their own language. In addition, the participants mostly searched and used these resources in the need of studying for some difficult courses. On the other hand, some students did not need to search additional resources. Two reasons emerged from this statement: first, they did not have difficulty on some courses yet and second their first choices were the instructional materials offered in their courses (books, articles etc.). One of the students mentioned his behavior for the first statement:

> *Gerek duymadım. Çok merak ettiğim bir şey olursa bakarım da, çok merak ettiğim bir şey de çıkmadı (SME #18)*
>
> *I've never needed that. I will check out if there is something that I want to learn, but there has never been so far (SME #18)*

4.3.1.1.2 Selection criteria of OER

The participants were asked to define their selection criteria while searching open educational resources. They basically mentioned four criteria, which were important for them. The first choice was related with the popularity of the universities and faculty members. Some universities (MIT, Yale, Khan Academy etc.), organizations and instructors were popular among students and they preferred to select their resources (N=6). One of the students explained her criterion below:

> *Bazen daha doğrusu büyük sözlük platformunda bazı hocaların ismi çıkmış durumda. Bu hoca iyidir, bunun dersi güzel anlatır falan şeklinde eğer varsa onların işte video arama sitelerinden onların derslerini aramaya çalışırım (SMI #14)*
>
> *If in some dictionary platforms some lecturers are mentioned like "this lecturer is good, s/he tells well", I may look for their lessons in video websites (SMI #14)*

In addition related with popularity factor, university's resources provided reliable source of information for participants (N=11):

> *Güvenilir kaynak, ders veren hoca mesela Yale'in felsefesini şey veriyordu, onların biraz altyapısına baktım, yayınlandığı kitaplar vesaire. Khan Akademinin güvenilirliği (SMI #18)*

Reliable sources, for example the lecturer was giving Yale's philosophy. I checked out their background, like their published works and such. The reliability of Khan Academy (SMI #18)

The third important factor was related with the quality and scope of the content (N=9). From a student's perspective, the factor was provided in the quote below:

Şimdi fizik için yanı adam derste mesela deneyi yaparak anlatıyor yanı bu insanı çekiyor ister istemez hanı bizde öyle olmuyor mesela ya da ne bilim liseden biliniyor diye anlatılmayan çok şey oluyor ama burada yanı izlediğim videoda mesela en küçük şeyi bile adam hanı anlatabiliyordu yanı benim acımdan bu çok iyi bir şey hanı çünkü ben lisede hanı onlar gibi bir eğitim alıp gelmedim (SME #6)

Well, in physics, the teacher explains the experiment while carrying it out which draws the student's attention anyway. But it's not the case for us. For example many topics are not explained considering they were taught at high school. But here in the video the teacher tells the slightest details. So it is very beneficial for me as I don't have the same background with others (SME #6)

The last important criterion for participants was parallel course content. Some participants searched the resources, which had similar content knowledge on their courses (N=6). However, while searching the resources, they faced with the problem of excessive source of information. This situation brought some difficulties for time, energy and reliability. Thus, most of the participants mentioned that within Middle East Technical University, instructional resources should be provided through OCW website. A student emphasized this suggestion as:

Okulun kendi kaynağı olursa daha rahat, hani başka okullarda var onlar işte, MİT'nin falan var, biliyorum onları da. Onlar her zaman bizim sistemimizle paralel olmuyor (SME #18)

It's better if the school has its own sources. They have them in other schools, MİT for example, I know that. They are not always in parallel with out system (SME #18)

Moreover, the participants who used open educational resources at once, planned to continue to use the resources in the future (N=17). One of the students explained his reason below:

Dediğim gibi illaki kullanırım, yani ihtiyacım illaki olacak. Her dersi yani derste anlayamıyoruz sonuç olarak. Böyle destekleyici şeyler olduğu zaman bu bir açıkçası dersane gibi, bir ekstra kurs gibi konuyu başka bir şekilde bir daha dinlemek (SMI #15)

As I said before, I will use it anyways because I will need it eventually. We cannot understand everything a hundred per cent during the lesson after all. When we have supplementary elements, they are like an extra learning hour outside the school; it gives us the opportunity to listen to the topic in a different way for the second time (SMI #15)

4.3.1.1.3 Beware of METU OCW

Regarding METU OCW, the number of awareness decreased to only four participants (students) and 8 students in total in two semesters. Only eight students knew OCW website. They were aware of the website by an e-mail sent by the institution, and by some friends. Regarding the OERs in general chemistry laboratory course, two students knew them before the course began. Other participants mentioned that they were first aware of them through the information given by the researcher in each week, e-mail sent by researcher through the semester, friends, social media and the information given by a teaching assistant at the beginning of the semesters but the most mentioned information channels were researcher (information and e-mails) and friends. After they learnt about them in chemistry laboratory course, only four students investigated the OCW website and other courses' resources. Other participants learnt the OCW website through the interviews at the end of the semester. They thought that the website only contained the laboratory resources. One of the students explained his behaviors as:

Aynen, bence duyurma eksiği var. Çünkü ben sadece sizden duydum. O yüzden sadece kimya için olduğunu sanıyordum (SME #11)

Definitely; I think they failed to announce, because I've just heard it from you. So I thought it was only for chemistry (SME #11)

Regarding teaching assistants in the course, only three assistants knew the website through posters about the OERs in library and by information from a friend but they did not examine the website and the resources. Regarding the laboratory course resources, most of them were aware of the resources at the beginning of the semester from their colleagues and one assistant were not aware of them until the researcher informed her. Similar with students' behaviors, only two teaching assistants looked OCW website and searched different courses in other departments. One of them expressed this behavior in the following comment:

> *Direkt şöyle söyleyim; diğer bölümlerde neler var diye şöyle bir göz attım, onlarda mesela dersler falan var, bizde niye yok falan diye ona baktım sadece (TA #3)*

> *Frankly, I took a quick look at what other departments have, for example they have some lessons and I just checked out why we don't have any (TA #3)*

4.3.1.1.4 Barriers to use METU OCW

Regarding the user profiles and awareness about METU OCW website, only small part of participants had an information about the website. Therefore, the barriers about this insufficient knowledge were provided under four factors.

4.3.1.1.4.1 Lack of awareness

In the same line with the results about the use of chemistry laboratory resources, the most mentioned barrier about the OCW website was the lack of awareness (N=28). One of the students explained this problem not to have a sufficient information about the website.

> *Metu nünkini kullanan hiç yok çünkü gerçekten haberimiz yok yanı kimyayla ilgili olduğunu mesela ilk donem de söylemişlerdi bir iki tanesi için o zaman kullanmıştım ilk donem de kullanıyordum bu donem sız haber verdiniz o yüzden kullanmaya başladık (SMI #2)*

> *Nobody uses METU's (OCW) because we hadn't heard about it, that it was related to chemistry. They just informed us about it at the first term, and that's when I used it. And this term, we started using it because you informed us (SMI #2)*

Some students also complained about the institution's policy about OCW. They throught that the institution should provide some advertisement and support to present the resources internally and internationally like other universities did. However, one of the students attempted to clarify this issue through receiver-type of students:

> *Birazcık da şöyle bir şey; artık üniversitenin bize vermek istediği mesaj mı bu tam olarak bilmiyorum ama büyüdünüz artık, bir şeyleri de artık kendiniz araştırın, keşfedin gibisinden. Şimdiye kadar hep hazıra alışmış geldik buraya. Ama burada biraz daha öğrenin böyle şeyleri gibi bir mesaj (SMI #15)*
>
> *It's a bit something like a message the university tries to give us, like we are grown-ups, we have to learn to make research and discover by ourselves. Everything has been within easy reach so far. But now, here, we have to learn how to do all these things (SMI #15)*

Therefore, while the institution were accused of having passive practices for the OCW website, the students' future behaviors were also determinant in this case. In the next section, the barriers based on students' behaviors and motivations were examined related with this issue.

4.3.1.1.4.2 Insufficient content

One of the most criticized barrier was insufficient content offered in the website (N=13). One of the students highlighted this problem from her experience in the website:

> *Ama ben işte size dediğim gibi daha önceden girip baktım hanı çok yetersiz olduğunu gördüğüm için çoğu kısının kanaati doğru düzgün video yok orda kanaatinde zaten bize ilk duyurulduğu zaman da şey demişlerdi hanı su anda çok bilgi yok ama hanı bunlar işte doldurulacak hanı geliştirilecek demişlerdi ama ondan sonra tekrar bir duyuru yapılmadı (SME #9)*
>
> *But as I mentioned before, I checked it out beforehand thinking it was inadequate. Most people are right, there are no suitable videos. Also they said at first that there wasn't much information available but they would be filled up and improved. But no announces have been made about it yet (SME #9)*

When the website first developed, the courses were not sufficient so that the students did not use the website for a while. Then, many courses were added (118 courses are offered in different departments) but the students were not informed about the new courses. Therefore, the courses were not still sufficient for each department. Especially some courses (calculus, physics etc.) could be provided in order to attract some students to use the website. One of the students criticized this issue from his perspective:

> *Genel olarak yeteri kadar popüler ama ODTÜ'nün ki kesinlikle değil. Birde sıkıntılı yani Bunu kimya için söylemiyorum ama ODTÜ'nün Open Course' na girdiğiniz zaman mesela her bölüm için açılmış bir şeyler ama bir bölümden mesela kendi bölümümden 3 tane ders var. Atıyorum mesela başka bir bölümden 4 tane ders var. Bu şekilde Open Course olmamalı. Havuz derslerin hiç biri yok mesela. Open Course genel olarak yetersiz ama bu kimyanın Open Course' nun yetersiz olduğunu göstermiyor (SMI #9)*

> *It's popular enough in general, but that of METU is definitely not. It also has some flaws. I am not saying this for chemistry but when you check out METU Open Course, you will see some courses for each department but from one course, like from one department, there are 3 courses of that department and 4 lessons from another. Open Course should not be in this way. There are no common courses, for instance. Open Course is insufficient but of course it doesn't mean that chemistry Open Course is insufficient (SMI #9)*

4.3.1.1.4.3 Lack of interest

The second issue about the use of OCW website was about the lack of interest of students through their courses (N=5). One of the students explained his behavior related with this issue as:

> *Ya hocam ben hiç bilen vardır da yanı çalışan insan bilir bunları daha çok çalışmıyorum derse zor gidiyorum bunu da hiç araştırmadım yanı bunu (SME #8)*

> *Well there must be some who knows this, mostly the hardworking ones. I don't study much, I even barely go to the lessons, so I've never thought about it (SME #8)*

While the students complained about the insufficient information about the resources, some of them criticized themselves as being uninterested in these practices. Thus, if they knew the resources, they possibly did not used them because they hardly studied in these courses. The dialogue between the researcher and the teaching assistant aimed to clarify this issue:

> Interviewer: *Peki, sence teşvik konusunda ne dersin mesela bu dönem giriyorsun genel kimyaya hani bu hiç duyuruldu mu?*

Interviewee: *Duyuruldu en başında duyuruldu. Zaten normalde yetmesi lazım, her hafta, her hafta hatırlatmamız lazım yani ama dediğim gibi yani ilgisi olan duydu haberi var. İlgisi olan dinliyor. Her hafta söylesen de dinlemeyecek olan yine dinlemeyecek yani (TA #6)*

Interviewer: *What about promotion? For example you take the general chemistry lesson this term, have you ever been informed about this?*

Interviewee: *Yes, at the beginning it was announced. Normally it should be enough. I mean we have to remind it every week again and again but those who have interest have already heard about it, they are informed. They always follow. If a student is not interested, s/he will never pay attention no matter how often you announce (TA #6)*

Similarly, during the observations experimental groups were informed in each week in the classroom and through e-mails. However, some students did not prefer to use the resources. Their reasons were diverse, which was mentioned in the use section, the most critical one was the lack of interest of students for the course.

4.3.1.1.4.4 Other factors

Some participants also mentioned some other factors. One of the barriers to use OCW website was an interesting one. Two students mentioned prejudices about the new practices and developments in Turkish Institutions:

Ya çünkü Türk insanının kendini aşağılama psikolojisi var ya biz yapamayız biz şeyiz diye ben çünkü hiç aklıma bile gelmemişti böyle bir şey olacağı hanı bir tek varsa Harvard da vardır MIT de vardır Yale de vardır bizde niye olsun ki falan hiç aklıma gelmemişti (SMI #5)

Well it’s because you know Turkish people have the tendency to degrade themselves like we can’t do this and such. So I’ve never thought we could have something like this. I thought only Harvard, MIT or Yale could have it. Like who are we to develop such a system? (SMI #5)

The second barrier was to be used to traditional studying activities. As similar with the students’ behaviors through OER use, some students also did not need to search additional resources and they did not familiar with the online resources offered for the courses. (N=3). Related with this issue, one of the students expressed his behavior as:

Benim de öncelikli olarak da gidip de METU 'nun herhangi bir uygulaması var mı diye düşünmekten çok, kütüphaneye gidip kitap almak ya da çıkmış soruları almak aklıma geliyor. Bu da hiç aklıma gelen bir şey olmadı (SMI #8)

I initially think of going to the library and finding the books or retired questions rather than thinking if METU has any application or not. I've never thought that way (SMI #8)

4.3.1.2 Academic Culture

Through this section, the use of OER by faculty members' and teaching assistants for academic practices their sharing culture were analyzed.

4.3.1.2.1 Use of OER

The faculty members were asked to define their course preparations and resources, which were benefitted from. One of the faculty member described that he mostly did not used online resources to create the course materials. He only used visuals and some information about the exams from the internet:

Interviewee: *Yani genellikle kaynakları ben kendim hazırlıyorum. Yani dışardan tabi bu özellikle genel kimyada hazır şeyler var ama cok bağımlı kalmıyorum.*

Interviewer: *Peki, yazılı veya basılı materyal olarak internetten yararlandığınız kaynaklar oluyor mu?*

Interviewee: *Tabi, özellikle daha advanced derslerle ilgili mesela ne bileyim bir bilgiye ihtiyaç oluyor o dersle ilgili. Hem sınavlarda kullanıyorum o tip şeyleri. Yani hem de ders anlatırken kullanıyorum. Yani tabi ki görselleri kullanıyorum. Bazı derslerim hala görseller üzerinden gidiyor ama hep kendi hazırladığım şeyleri kullanıyorum. Dışardan pek kullanmıyorum yani (P #1)*

Interviewee: *Well, generally I prepare the resource by myself. Of course there are –especially in general chemistry- available resources out there, but I try not to be dependent on them.*

Interviewer: *So, do you have any written or printed online resources?*

Interviewee: *Of course, mostly related to the advanced lessons. For example we need some information about that lesson. So I use them both in the exams and during the lessons while I'm lecturing. Of course I am using the visuals. Some of my courses are still going on with the visuals but I always use the* *materials I prepared by myself. I don't use many materials from somewhere else (P #1)*

Two faculty members were more prone to use different online resources regarding visuals, e-books, videos, simulations etc. While their first choice was the original books of the courses, they found different resources to prepare course materials. They also directed the students to use different resources from other universities (MIT, Harvard etc.). These statements were provided with the dialogue between the researcher and faculty member:

Interviewee: *Normalde diğer verdiğim dersler olarak mesela organik kimya dersi veriyoruz mecburi derslerde. Onda çok bir ihtiyaç olmuyor internet üzerinden kaynak araştırmakta, bilgi araştırmakta fakat benim başka bir dersim var chemistry popular culture diye, yani tamamen ona dayalı bir ders. Yani araştırmaya dayalı bir ders olduğu için o dersin içeriğinde zaten tamamını internet üzerinden araştırma yaparak oluşturdum.*

Interviewer: *Peki, başka üniversitelerin hiç böyle kaynaklarından faydalandığınız oldu mu? Ya da hiç fark etiniz mi?*

Interviewee: *Genelde sınav ve soru bakımından faydalanıyorum. Kimilerini öğrencilere de yolluyorum çalışma sorusu olarak kullanabilirsiniz diye. Onun dışında başka üniversitelerin kaynakları… Genelde o kadar. Organik kimya dersi için Harvard'ın çok güzel bir şeyi var. Organik kimya, advanced organik kimya ders notları var. Ondan çok kendim için de faydalanıyorum. Ders için değil de kendim için de, öğrenmek için de çok faydalandım (P #3)*

Interviewee: *Normally for other courses, we give organic chemistry as a compulsory course. In that one, there is not much need to search online resources or information from outside. But I have a course called chemistry popular culture. It's completely based on doing research, that's why I prepared the context completely from online resources.*

Interviewer: *And have you ever made use of the resources of other universities? Or have you ever realized?*

Interviewee: *I generally use them for exams and questions. I also send some of them to the students so that they can study on them. Well, other than that… mostly I just use them for these purposes. Harvard has something very beneficial for organic chemistry course such as advanced organic chemistry lecture notes. But I use them rather for myself. I used them not for my courses but for my own research (P #3)*

As mentioned by the faculty member above, they also used open educational resources for their personal interest and development:

> *Şimdilerde daha çok şeye bakıyorum hani kendimi geliştirmek adına bu Edex tarzı ama katılabiliyor muyum dersen valla herhalde 8-9 derse katılmaya çalıştım, hiçbirini bitiremedim. Bitirmek değil, ilk iki hafta üç haftası sonrası devam edecek enerji, vakit ayıramadım ama hani bence çok faydalı ve kendimizi geliştirmek açısından tabii çok farklı alanlarla ilgileniyorum orada o yüzden aslında Edex'le ilgileniyorum ama...(P #2)*

> *Nowadays I am looking at more things now than I am in this Edex style for the sake of improving myself, but if I can participate in, I tried to attend 8-9 lessons, I could not finish anything. I can not spare and energy time after 2-3 week, but I think it is very beneficial and I am interested in many different areas of course to develop ourselves, so I am actually interested in Edex (P #2)*

4.3.1.2.2 Sharing culture

The faculty members and teaching assistants used open educational resources for their teaching and learning activities. The resources in chemistry laboratory course as an open educational resource, it was important to examine their sharing culture of the information and resources. This culture also revealed some ideas about practices to develop new resources. Four faculty members did not have an experience for sharing their resources in any platforms. They benefitted from OERs but they did not eager to share their resources. They had some concerns about sharing which were examined through five parts.

4.3.1.2.2.1 Reference concern

The first concern about sharing was providing reference for the content in the resources (N=2). Faculty members did not want to deal with the copyright problems.

> *Kendi kaynağım şöyle normalde mesela chemistry popular culture dersi için aslında ben öğrencilerimle paylaştım. Açık herkese şey yapmadım. Orada biraz telif hakkı sıkıntıları olacağı endişesiyle video görüntüleri vs. olduğu için böyle birazcık usulsüz yollarla edinilmiş görüntüler olabileceği düşüncesinden diye çevireyim o yüzden onları o nedenle paylaşmamayı, internette paylaşmamayı seçtim. Ama öğrencilerimle paylaştım, paylaşıyorum (P #3)*

I actually shared my own resources with my students for chemistry popular culture course, but I didn't share them publicly. I preferred not to share them online thinking there could be some problems about the copyrights; you know the videos may have been procured illegally, to be honest. But I've been sharing them with my students (P #2)

4.3.1.2.2.2 No need to provide resources

The second idea about sharing was related with the necessity to share personal resources (N=2). A faculty member thought that the current resources were enough to provide sufficient content and activities for students so that he only directed students to use those resources.

Yani genel kimya dersinde kitabın çok güzel şeyleri var. Online sunumları ve problemleri var. Dolayısıyla hani bize hiçbir şey kalmıyor. Hani şey anlamda tabi, tühh kalmıyor değil de tabi, yani kalmıyor. İyi oluyor bir açıdan. Görsel malzemeleri filan da çok güzel. Hoş ben slayttan anlatmıyorum genel kimyayı ama sadece bir derste kullanıyorum onu. Çünkü çizmem çok zor bazı şeyleri. Orada kullanıyorum. Onun dışında bütün dersleri tahtada anlatıyorum. Ama slaytları paylaşıyorum öğrencilerle. Dolayısıyla onlarda da hakikaten syllabus dışında koyabileceğim bir şey yok yani. Genel, organik kimya dersinde de aynı şekilde, verdiğim, en çok verdiğim dersleri düşünüyorum o yüzden onda da öyle bir syllabus dışında oluşturduğumuz bir kitap dışında kendi bir görselimiz, bir çizimimiz olmuyor. Sınavlar var sadece. Sınavları da genelde tabi ortak verdiğimiz için dersi kendi başıma olsa paylaşalım dicem ama…(P #2)

Well, the textbook is useful for general chemistry course. It has online presentations and problems. So, nothing falls to us, which is good. Also the visuals of the textbooks are very good although I don't use many presentations in my classes except for one as it's hard to draw some things, so I use presentation for that class only. In other courses I just use the board. But I share the slides with the students. So there are not many things that I can add aside from the syllabus. Considering the courses I give most, we don't have any extra visuals or drawings of our own beside the syllabus and the book that we prepared. We only have the exams; and of course if the exams weren't mutual we could have shared them like we do for courses (P #2)

4.3.1.2.2.3 Personal concern

Another mentioned concern was related with personal characteristic of a faculty member. He expressed that he mıght not be feel comfortable in front of people through the video in the internet.

Interviewer: *Peki, yani gördüğüm kadarıyla hani siz bu tarzdaki açık ders kaynaklarını destekliyorsunuz peki, siz kendi materyallerinizi paylaşma konusunda nasılsınız?*

Interviewee: *Sınıf içinde çok açığım, yani ben kendi materyallerimi kendi sınıfımda paylaşıyorum yani bu işte slaytlarımız olsun vesaireler falan ama videoya çekilip koyalım meselesini daha düşünmedim mesela. Çekingen bir insanım belki ondan. Yani işte çekilip başkaları tarafından seyredilmesi fikri, bilmiyorum hiç düşünmedim onu (P #2)*

Interviewer: *Well, obviously you're in favor of open course resources. So what about you? How do you feel about sharing your own materials?*

Interviewee: *It is OK for the class. I mean I share my own materials in my classes like the slides and such but I've never thought about videotaping my lesson and posting it online. Maybe it's because I am introvert. The idea that I am videotaped and watched online by others is weird (P #2)*

4.3.1.2.2.4 Academic concern

Two faculty members mentioned that the source of information was important in academic culture. Therefore, sharing information could create an unbalance between the faculty members. He expressed his concern in detailed as:

Yani, publication yapmadım. Yani onu resmileştirmediğin zaman şey olmuyor. Tabi o biraz hani toplumsal olarak gidiyorsunuz bilgiyi kim üretti, kim üretmedi olayına geliyor. Bilgi evrenseldir diyoruz. Evrensel olması doğaldır ama bunun üniversiteler içinde, yani bilgiyi üretiyorsunuz, ürettiğiniz bilgiyi al kullan dediğiniz zaman size geri zekâlı muamelesi yapılıyor. Çünkü bir başkası alıp bilginizi yükselebiliyor, siz hala bilgi üretmenin hazzı içindesiniz. Ve onlar çıkıyor sizi değerlendirenler pozisyonlarına gelebiliyorlar. Yani bilgiyi üretene aslında sizsiniz. Ama onlar çıkıyor o bilgiyi kullanarak üstünüze çıkıyorlar ve sizi değerlendirmeye başlıyorlar (P #4)

Well, I've never had any publication. I mean it's not valid unless you officialize it. And socially it is a matter of who produced knowledge and who didn't. We say knowledge is universal, it is natural that it's universal; but at universities, when you produce the knowledge and let other people use it, you're treated as an idiot. You know, some other academician can steal your knowledge and promote to higher positions while you take pleasure in producing knowledge. Then they get to the position to evaluate you. I mean it's you who produces knowledge but others use that knowledge to be in a higher position than you and start evaluating you (P #4)

4.3.1.2.2.5 Lack of time and organization

The last concern about sharing was lack of time and organization to create and share the resources. (N=4) The major problem was to create and then update the resources based on technological developments. One of the faculty members explained his concern in her quote below:

> *Evet, şey olabilir ama benim ona tek başına yetişmem mümkün değil. O kafamda çok fazla oluştu, başlarda yapmaya çalıştım. Ama tek başıma yetişebileceğim bir şey değil. Bu konuda buradaki tüm hocaların hem fikir olacağını düşünüyorum, yani ben oturup şey mi not mu hazırlayacağım, ders mi hazırlayacağım, o dersi düşünecek miyim, yoksa bunları online da mı koyayım, şöyle olsun böyle olsun falan. Yani burada bir de teknoloji çok çabuk gelişebiliyor ve gelişiyor da orada hani onu da yakalamak gerekiyor bazen (P #4)*

> *Yes, it might be, but it's impossible for me to deal with it on my own. I planned it in my mind and tried to do it initially but it wasn't something that I could cope with by myself. I believe that other teachers will also agree with me. Like, should I prepare notes, or courses, ponder upon that lesson or post them online and so on? And also technology is growing fast; we should also catch up with it as well. And I don't have many materials for other stuff. I mean I haven't prepared any resources for organic or general chemistry courses (P #4)*

In addition, some faculty members used prepared resources and they did not created own resources created by their profession so that they did not have any resource to share:

> *Onun dışında zaten diğer şeylerde kendi malzemem yok. Hani organik kimya da genel kimya derslerinde oluşturduğum bir kaynak yok (P #3)*

> *Other than that, I do not have my own stuff in other things. I do not have a prepared source for organic chemistry or general chemistry classes (P # 3)*

The last mentioned issue was the lack of organization. A faculty member did not attempt to share his resources personally; rather he expected to participate in more organizational implementation and direction:

> Interviewer: *Peki, neden hazırlamadınız? Yani vakit sıkıntısı mı yoksa hani başka nedenler mi?*

Interviewee: *Yani öyle bir talep gelmedi kimseden. Ne bileyim yani o talebi ben mi yaratmalıyım yoksa başka biri talep etmeli ben ona katkı mı vermeliyim bu konu hiç tartışılan bir konu değil. Hani bir farkındalık da yok belki. Ama öyle bir proje çıksa ortaya yani biz desek ki mesela üniversite çapında burada üretilen bilgiyi Türkiye kamuoyunun kullanımına açacağız. Ona katkı veririm ama ne öyle bir istek oldu ne böyle bende de yani kime ulaşacağımı bilmiyorum. Ama yani çok şeye katılırız mesela davet edilen toplantılara katılırız, konuşmalar filan ama böyle hani daha teknik içerikte bir şey hiç olmadı (P #1)*

Interviewer: so why didn't you prepare one? Is it about time management or did you have any other reasons?

Interviewee: well, nobody made a demand about that. I mean it has never been discussed if we should create that demand or it should come from others and we just contribute to it. And I guess there is no awareness either. But in case such a project is made and we as university say ok, we will put the knowledge produced at our university into the service of the Turkish public opinion, I will definitely contribute to it. But neither there was such a demand, nor had I anybody to talk to about this subject. We do attend the meetings and talks to which we are invited, but we have never heard about a project with technical context so far (P #1)

4.3.1.2.3 Openness

Regarding sharing the resources, faculty members and teaching assistants were asked their knowledge about the *creative commons*. Except two instructors, they were not familiar with the open licenses to share their resources. One of them shared his comment about this issue as:

Hiç bilmiyorum. Telif haklarıyla ilgili bir düşüncem olmadığı için. Creative Commons'ı duydum ama hani çok ayrıntı hiç telif hakkım ne olacak endişem olmadığı için, sınavlarımızı fotokopiciler basıp sunarken biz telif hakkımızı düşünmüyoruz (P #2)

I have no clue because I've never thought about copyrights. I heard about the Creative Commons, but it's of too much detail. I've never concerned about copyrights; we just give our exam sheets to the photocopier and forget about this matter (P #2)

Because the instructors did not share their resources yet, they did not have information about licenses. However, it was interesting that while they were using the online materials, they were not interested in 4R rules in OER, which enable users to decide how to use the resources. During the interviews, some information were given to participants about the rules but while some students supported the *open* use of resources, some of them had some concerns in reality. One of the major concerns about these rules was the reliability of the information. One of the students expressed her idea as below:

> *Kendi amacım için kullanırım tabi. Ama şeydekini zaten değiştirme yetkimiz olmamalı, hocanın kendi koyduğu şeyi bizim onun üstünde değiştirmemeliyiz zaten. Sen bir şeyi değiştirirsin, onu kendi başka bir yerde yayınlarsan gerekli işte izin alıp onda bir sıkıntı yok yani (SME #18)*
>
> *I of course use it for my own purposes. But we shouldn't have the authority to change anything the teacher prepares. If you change something and publish it somewhere else, then you need to get permission (SME #18)*

Another concern was related with the sources of the information, which some participants wanted to know the *owner* of the information (N=5). However, for this subject students did not have sufficient information about the open features of the resources so that it could not be realistic to except them to criticize this issue properly.

4.3.2 Department Support

Regarding OERs, one of the major questions was how the Chemistry Department supported the use of them. Among teaching assistants and faculty members, there were different ideas about the departments' policy. Two participants mentioned that the department gave sufficient support for the OERs. They thought that the department spent enough time and energy regarding the practices about the resources. One of them explained his statement regarding this support as:

> *Geçen gün Kürşat Hoca geldi siz de geldiniz, bölüm başkanı görüştü sizinle. Yani niye öyle oldu, niye bölüm başkanı zamanını verdi, bölüm başkanı da sonuçta bir öğretim üyesi burada ama bölüm başkanı olarak size bir süre ayırdı. Bu ne demek oluyor, bu bölümün aslında bu işleri önemsediği anlamına geliyor. Biz öğrenciyi en kaliteli şekilde yetiştirmek için elimizden geleni yapmaya çalışıyoruz (P #4)*

> *That day, you and Kurşat hoca came and had a talk with the head department. Why should a head department spare time for that? He is also an academician but he spared his time as a head department after all. It means the department pays attention to such projects. We are trying our best to raise our students at the most quality level (P #4)*

Between the two semesters in data collection process, a meeting was arranged between the researcher and the department. Beside head of the department, six faculty members attained the meeting to discuss the future developments about the resources. Decisions were to create similar resources for different Chemistry courses, and to update the current resources. However, after the meeting, the decisions were not put into practices. In addition, the communication between the department and researcher was at minimum level for this subject, which the faculty members did not get into contact for resources with the researcher. Like this problem, after developing the resources, the department had have the similar approach. The resources was made at the beginning but no attempt was applied to improve or develop the resources. A research assistant criticized this issue from his perspective as:

> *Çok fazla desteklendiğini düşünmüyorum çünkü çok fazla destekliyor olsalardı hani üzerine bırakılmazdı, şu an biraz yapıldı, konuldu ve orada kaldı şeklinde oldu. Hani çok fazla desteklenmesi demek bunun update edilmesi demek, sürekli konuştuğumuz hadise, geliştirilmesi demek, geliştirilmesi için çaba sarf edilmesi demek. O konuda biraz şey oldu, güzel oldu yapıldı ama orada nokta konulup bırakıldı gibi oldu (TA #10)*

> *I don't think it is supported much, because if they did, the job wouldn't have been fallen to us, now it's like they initiated something, but then left it incomplete. Supporting means updating and improving the project, as we said before. Ok, it was good at the beginning, but they didn't complete it (TA #10)*

As seen in the comment, at the beginning of the project (creating the OERs), the department provided sufficient support for the resources with all the effort but after some years, a breakpoint occurred which changed the perceptions about the resources in the department. Thus, in the following part, the problems and concerns about the resources, which affected the support of the department, were discussed under four issues: personal, system-related, resource-related and organizational issues.

4.3.2.1 Personal Issues

The first issue, which decreased the support for the resources, was related with the personal concerns and problems of faculty members and teaching assistants.

4.3.2.1.1 Academic Concerns

For a faculty member, academic development was one of the major purposes in their profession. These developments could prevent the faculty who mostly preferred to spend their time on academic developments from focusing on improvements for the courses (N=4). One of the faculty members indicated this issue as:

> *Yani evet genelde işte her bölüm ve herkes genelde gençlerden bir şeyler beklerken gençlerde şey oluyor, üzerinde bir sürü yük oluyor, işte doçentlik işte araştırma şey yapmam gerekiyor vesaire. Paralel götürmek bazı işleri zor (P #3)*
>
> *Yes, in general every department and everybody expect something from the youth while the youth has too much burden on their shoulder such as associate professorship things and all the research. It's hard to do everything all together (P #3)*

In addition, General Chemistry course did not offer any academic reward for faculty members and teaching assistants. One of the faculty members explained why the faculty did not prefer to spare their time for these improvements in detailed below:

> *Şöyle bir sıkıntıyla karşılaşıyoruz. Öğrenci çok fazla, öğretim üyesi sayısı az genellikle ve bu hakikaten tamamen kendini adamışlık gerektiren bir şey. Oraya adayacaksınız. Ama maalesef onu da öğretim üyeleri yapmıyorlar. Çünkü bunun hani akademik değerlendirmede bir karşılığı yok. Çok zaman koyacaksınız ama özellikle gençler böyle bir şeye rağbet etmez. Çünkü getirisi yok. Getirisi olmayınca ne yapıyorlar, işte getirisi olan makale yazmak filan daha görünür şeylere zaman ayırıyorlar (P #1)*
>
> *We encounter such a problem: the number of the students is high while there are few academicians, so it requires a real devotion. But unfortunately the academicians don't devote themselves, as they gain nothing in academical evaluation in response. You need to give too much time, but especially the young generation doesn't buy into such a work, because it has no benefits. So*

what they do in this case is to spare more time on more visible works like writing an article (P #1)

Therefore, some academic developments and lack of time decreased the support for the course and the resources also.

4.3.2.1.2 Adaptability for Educational Innovations

Some faculty members and the teaching assistants were criticized of not being adaptable for the new developments and practices (N=6). Especially the old faculty members were claimed not to be familiar with new practices:

> *Hocaların özellikle belli bir yaş üstü hocalarımız zaten bu tarz şeyden zaten kendileri de kullanmadığı için çok fazla sevmiyorlar diyeyim, o yüzden çok fazla öğrenciyi de yönlendirmemiş olabilirler ama genç hocaların biraz daha bu konuda iyi olduklarını tahmin ediyorum hani ben hiç derse girmedim, net bir şey söyleyemem ama genç hocalar çok seviyorlar bu tarz şeyleri, daha yatkınlar, daha bu tarz işlerle haşır neşir oluyorlar. Dolayısıyla onlar yönlendiriyordur diye düşünüyorum ama hani belki biraz daha artık dersin standardı da oturmuş, sürekli aynı şekilde anlatan hocaların çok fazla koymadığını, ilgilenmediğini, bunlara çok fazla da kanalize etmediğini öğrencileri...(TA #10)*

> *Well, let me explain this way, most of our teachers especially those of older age don't appreciate such projects. So it is normal that they might not canalize too many students to them. But I predict the younger ones are better in that matter although I cannot make a certain comment, as I haven't taken any lectures. Young lecturers are more interested in such projects; so I think they are the ones who canalize the students. But when we think of the lecturers whose courses have been standardized, who has a certain, strict way of teaching, they are not very interested in this projects, so they don't put them in their lessons or canalize the students to them (TA #10)*

One of the teaching assistants clarified this issue by resistance for the educational developments and practices through the dialogue as below:

> Interviewer: *Sence neden hocalar böyle bir şeyi teşvik etmiyor, sen hocaları daha iyi tanıdığın için soruyorum?*

> Interviewee: *Valla onun cevabını bilsem:) Yani neden görsel kullanmıyorlar mesela? Yani neden daha efektif bir ders anlatım biçimine geçmiyorlar hiçbir fikrim yok. Yani artık bence bazı hocalarda genellikle genç hocalar çok daha*

> *iyi bu konuda. Yaşın getirmiş olduğu şeyle belki hani emekliliği gelmiş hani bir salma durumu oluyor. Bunca senedir anlatıyorduk herkes ne güzel öğreniyordu gene öyle devam eder gibi bir mantık var benim gözlemlediğim kadarıyla çünkü hiçbir yenilik yok (TA #7)*
>
> Interviewer: *Why do you think the lecturers don't encourage the students to take part in such a thing? I am asking you, because I think you know the lecturers better*
>
> Interviewee: *Well, I wish I knew the answer. Like why don't they use visuals? I have no clue why they don't adapt their lessons to more effective methods. Some young lecturers are better in this matter if you ask me. Maybe it's because they are at the end of their journey, they will retire soon, so they might give up on such things. Maybe they have the assumption like "We've been explaining things in this way for ages, and the students have learned everything, so why bother?". This is what I observed; there is no innovation in their methods (TA #7)*

Thus, especially the experienced faculty members could not be open to investigate and develop new practices because they did not want to change the way they teach and offer the courses.

4.3.2.2 System-related Issues

4.3.2.2.1 Attitude to General Chemistry Course

As provided detailed in use and implementation sections, one of the major problems related with the general chemistry course revealed the students' attitudes towards the course. Most of the students did not value enough this course, which brought decrease in interest and motivation for the course. The faculty members were aware of the lack of interest so they had concerns as if the students would use the optional resources in their learning process. Unfortunately, this problem was also observed from the faculty side (N=7). The participants did not refer to any person related with this issue but they portrayed the general atmosphere in the department as one of the faculty members stated below:

> *Hani sonuçta çoğu insan genel kimya üzerinde, özellikle 107'de hani biraz külfet bir ders fazla istenilmeyen bir ders servis dersleri. Hani işte bize bir faydası yok, şimdi kimya öğrencisine verilen her şeyin aslında bir geri dönüşü*

olacağı için ileriki yıllarda, bu da öğrencilerde bize bir faydası yok şeyiyle hani çok büyük bir çaba göstermeme gibi bir durum diyeyim. Bazı hocalarda en azından birkaçında gözlemlediğim şey var, işte genel kimyayla uğraşıyoruz, ne olacak ya niye boşuna uğraşıyoruz ki. Böyle bir başka bölüm dersinin bir görüntü şeyleri olsa işte organik gibi ondan çok daha sahiplenilirdi diye tahmin ediyorum (P #3)

Most people have general chemistry, especially 107 is a burden on the students' shoulders. Service courses are the unwanted ones. So they have no benefits for us. For example, everything given to the chemistry students comes back to them in the future somehow. So when the students think the courses are useless, they don't pay much attention. What I observed at some of the lecturers is that they say "We are dealing with general chemistry in vain, so why should we make an effort?" If there were another department's visuals, organics for instance, they would be embraced more, I guess (P #3)

As seen in the quote above, general chemistry course was seen as a burden by some faculty members, which did not have a contribution for Chemistry Department. This perception could also be valid for some teaching assistants, which resulted in decrease in their motivation and interest for the course and resources. One of the teaching assistants explained this issue in his quotation below:

Hani genel kimya sonuçta hani çok ne bileyim bazılarına angarya da geliyordur hani bu öğrencinin zaten ne işine yarayacak ki deneyini yapsın gitsin mantığında olabilir asistan, dolayısıyla çok fazla yönlendirmiyordur. Belki kendisi de hiç merak edip girip bakmamıştır ya da hani şey yapmamıştır, onun ilgisini çekmemiştir. Bir şey sizin ilginizi çekmiyorsa başkasını da yönlendirmezsiniz. Onun bir kere videolar ilgisini çekmediyse o da öğrenciyi yönlendirmeyecektir (TA #10)

Well, the assistant may not canalize the student thinking that it's general chemistry after all, it's like a donkey work; what is the student going to do with it practically; so they may just let them do the experiment and go. Maybe the assistant her/himself has not even checked it out or had any interest in it. If you're not interested in something, you don't lead anyone to that direction. If the videos haven't grabbed his/her attention, they just won't direct the student to them (TA #10)

Similar with students' using behaviors, some teaching assistants also did not have an interest or need for the resources so that this behavior leaded to insufficient direction of student to the resources.

4.3.2.2.2 Interrelation between Faculty and Laboratory Course

Derived from the observations and interviews, there was a disconnection between the faculty members and the general chemistry laboratory course. As mentioned in the previous issue, the faculty members did not spare their time in laboratory environment. In two semesters as observed, only one faculty member who was responsible instructor for the laboratory course came over for couple of times to check the environment. This faculty member did not stay long in the classrooms and the other faculty members who taught the main general chemistry course did not come to the classroom. Thus, the teaching assistants mainly operated the laboratory course so that this situation brought some problems for the use of OERs.

4.3.2.2.2.1 Teaching Tradition

Regarding teaching tradition, the teaching assistants mainly handled the general chemistry laboratory course and the faculty members had a minimal effect on the system (N=3). A faculty member explained this tradition below:

> *Yani asistanlara bırakılıyor bütün şey, sorumluluk. Yani hocanın girmesi lazım ama bu da hakikaten en az bir günlük zaman şeyi. Belki haftada birkaç kere gireceksiniz. Yani bizim geleneğimizde olmadı. Yani hiçbir zaman olmadı. Hocaların hiçbir zaman laboratuvara girip başından sonuna kadar, birkaç hocamız vardı eskiden. Emekli oldular filan, yoklar şimdi. Öyle bir sorunumuz var bizim. Bu iyi bir şey değil tabi ama. Maalesef böyle işliyor (P #1)*
>
> *So I mean all the responsibility is left to the assistants. In fact the lecturers should enter the lessons, but it really takes at least one day. In some cases they need to enter a couple of times a week. But it has never been a tradition for us. I've never seen the lecturer enter the lab and give a lecture from the beginning to the end. There used to be some, but they retired. So we have such a problem. I know it's not good, but things go on like this here (P #1)*

Two directions could explain this attitude: lack of interest and time, and excessive number of students. The former one was related with the lack of interest for the course, which made them to focus on subjects that were more important. Some faculty members had the same attitude with the students who did not want to spare much time for this course.

Yani laboratuvar tabi zaman alan bir şey. Keşke biz gidip otursak o da çok daha iyi olur yani. Laboratuvar şeyi. Ama bir zaman meselesi ve zaman ayrılmıyor yani genelde. Yani ne öğrenci ayırıyor, zaman ayırmak istiyor laboratuvara… Sadece deneyi bitirip işte neyse en kısa zamanda bitirmek (P #1)

Well, lab takes time. I wish at least we went to the labs, it would be even better. But it's a matter of time, you need to spare time for the labs. But the students don't want to spend time in the labs. All they want is finish the experiment as soon as possible (P #1)

The latter one was the excessive number of student and classes. The faculty members did not have much time to fully participate the classes because ten departments and more than five hundred students required sparing all the time in the classrooms. Thus, this situation was not practical in this system for faculty members. However, the desired application was determined by faculty members to participate the laboratory classes more.

4.3.2.2.2.2 Communication

Related with the teaching tradition, the communication between the faculty members and students were at minimum level for the laboratory course (N=2). One of the faculty members claimed this problem as:

Yani bizim mesela fen alanında, temel bilimlerde şeyden farklı gidiyor mesela. Mimarlığın, şehir planlamanın atölyeleri çok önemli, stüdyoları. Hocalar giriyorlar, bizzat giriyorlar yani onun parçası. Bizde girilmiyor. Gerçekten. Laboratuvara hocalar girip başından sonuna kadar oturmuyorlar. Yani bizim laboratuvarda öğrenci ile doğrudan ilişkimiz olmuyor (P #1)

Well, the lab system in our field –applied sciences- is different from that of departments such as architecture or urban planning whose ateliers and studios are very important. In those departments, lecturers attend the labs personally; the labs are the part of the department. In ours, they really don't attend. The lecturers never attend the lab hours and stay till the end of the classes. I mean, in our labs we don't have direct relations with the students (P #1)

The students saw the faculty members only in the main course classes so that they mainly communicated with teaching assistants for laboratory course. In addition, during the semester, the teaching assistants were not have a regular communication with faculty members for this course. While some faculty members asked the students' experiences related with the laboratory course, this communication was not oriented by the improvement of the course and particularly OERs. Thus, faculty members did not have much information about the laboratory course and especially resources because they did not also take feedback from the students to improve the quality of the course.

> *Yani genellikle bizim laboratuvarla ilgili öğrenci deneyimlerini mi desem çok bir feedback de almıyoruz, sormuyoruz yani. Nasıl daha iyi olabilir, memnun musunuz diye (P #1)*
>
> *When it comes to the experiences of the students about labs, we don't get much feedback, we don't even ask how it can be better or if they are pleased with them (P #1)*

Thus, this teaching tradition affected the quality of communication between the students and faculty members about the laboratory course. In addition, this lack of communication alienated the faculty members from the process and development of the laboratory course.

4.3.2.3 Resource-related Issues

4.3.2.3.1 Encouragement

The first issue was related with the encouragement for the use of the OERs. For the encouragement issue, the quality of advertisement was firstly examined. While some faculty members declared that they informed the students in their classes about the resources (N=3), the general perception was oriented by the lack of advertisement in the department (N=13). One of the teaching assistants mentioned this issue in the dialogue below:

> Interviewer: *Yani sence bu sistem, sizin kimya bölümünde yeterince duyuruluyor mu?*
>
> Interviewee: *Kesinlikle duyurulmuyor. Biz yeterince söylüyoruz zaten sizde söylemiştiniz böyle bir şey, ha hiç duymadık, hocalar bile bilmiyor böyle bir*

> *şey olduğunu. Daha çok ön plana çıkarılmalı bence yani linkin nerede olduğunu bile bilmeyen çok insan var (TA #7)*
>
> Interviewer: *So do you think the students in your department are informed well enough about this system?*
>
> Interviewer: *Absolutely not. We always say that, and you did as well, we never heard about it. Even the lecturers have no idea. It should be emphasized more. There are many people who don't even know where the link is (TA #7)*

As seen in the quote above, there was a problem about providing the information about the resources. One of the major reasons for this issue was lack of awareness about the OERs. Similar with the students, some faculty members and teaching assistants were not familiar with resources. Among participants in this research, teaching assistants had more information about the resources by dealing with the laboratory environment more than faculty members did but they also were not successful to provide sufficient information and advertisement for students. Thus, the participants who were familiar with the resources also had some problems to encourage the students about the resources. Some participants criticized themselves and other faculty members for the insufficient encouragement for the use of resources. One of the faculty members shared his memory about this issue:

> *Kendi öz eleştirimi yapayım. Demin hani derste opencourseware den öğrencilere bahsettim dedim ama bunu belki iki sene yaptım sonra unuttum. Mesela ben toplantıya geldik, ben böyle şeyi hatırladım, son birkaç derste, dönemde yani hiç böyle dönemin başında bundan bahsetmediğimi hatırladım. Böyle utandım. Bununla yüzleşeceğimi biliyordum bu görüşmede. Yani belki işte unuttum. Yani hatırlatılması gerekir (P #3)*
>
> *Let me make a self-criticism: you know I just said I told the students about the opencourseware in my lesson. But I did it just for two years and then I forgot about it. So, I came to the meeting and remembered, I remembered that I've never told the students about this in any lesson at the beginning of the term. I feel ashamed. I knew I would face it in this meeting, well I just forgot about it. I mean we must be reminded (P #3)*

Moreover, the teaching assistants and faculty members had an important role to provide sustainability for the resources. However, most of them did not emphasized to use the resources through the semester. One of the teaching assistants explained her experience as stated below:

> *Ben sadece dönemin başındaki o da kendi çabamla değil, çocuklara işte opencourseware ler var, isterseniz videoları ve simülasyonları yapabilirsiniz dediğinde duydum ben de. Dolayısıyla dönemin başında bir kere söylendi ve hani biz dönem içinde hani zorlanıyorsanız böyle hani hakketen aklımıza gelirse eğer özelikle mesela bir vurgu yapmadık hiç. Çocuklar videolar var, izleyebilirsiniz isterseniz gibi bir şey yapmadık. Dolayısıyla o sadece dönemin başında bir kez söylenen bir şey gibi kaldı. Daha çok evet söylenmesi, bahsedilmesi gerekebilir (TA #8)*

> *I also heard about it only when the students were told at the beginning of the semester that there are opencoursewares, they can watch the videos and do the simulations. I mean it was only announced once at the beginning and we never told the students that they can watch videos if they have difficulties or something. It should be mentioned more often (TA #8)*

Therefore, beside lack of awareness about the resources, sufficient encouragement were not provided by some faculty members and teaching assistants. Faculty members were not practically responsible for laboratory practices so that faculty members could not feel responsible themselves to inform the students about the resources. During two semesters, except the beginning of the first classes, any announcement was made for students about the OERs. As highlighted in the quote above, at the beginning of the semesters, responsible teaching assistant referred to resources briefly at the end of the general announcements about the course so that most of the information about the resources was barely heard and understood by students.

4.3.2.3.2 Adopt the Resources

The second resource-related issue was related with the adoption of the OERs. Some faculty members had the impression that they did not embrace the resources appropriately (N=2). One of them criticized this issue as follows:

> *İnsanlar bir işin içinde oldukça sahiplenir, senin yaptığın bir işi ben sahiplenmem tamam mı tamam arkadaşımsındır tanıdığımsındır şuyumdur buyumdur bir neyse bir iki söylerim ama çok fazla sonuçta Seçil yaptı derim bir sıkıştığımda değil mi? Biraz şey olması gerekiyor sahiplenmek için ona*

biraz katkıda bulunmak gerek. Ben kendi açımdan sahiplenemediğimi düşünüyorum (P #4)

People only adopt something when they are into it. I don't adopt what you do. Ok, we might be friends or something, I can tell once or twice, but when I'm in trouble I just say Seçil did this, right? One needs to contribute to a work in order to adopt it. I don't think that I did in my case (P #4)

Therefore, some faculty required being more involved in the development process of the resources, on the other hand, they were less encouraged to adopt the resources.

4.3.2.3.3 Quality of the Resources

The last resource-related issue was about the quality of the resources. The negative feedbacks about the resources could have an undesirable influence on the support for them (N=4). One of the faculty members described his position about the quality issue as below:

Ben nasıl düşündüm, ben o zamanlar yararlı olduğunu düşünmüştüm ama sonraları bir şekilde geri çekildim nedenini de şöyle söyleyeyim çok zaten seyrettik bunu genel kimyalar için söylüyorum zaten seyrettik hocam bir daha 5 dakikamızı niye oraya verelim muhabbeti geldi (P #4)

How did I feel? I thought it was beneficial at that time, but later I hesitated because the general chemistry students said things like "we already watched this, why do we waste 5 more minutes on it? (P #4)

The second argument about the resources was related with the lack of awareness about the necessity and quality of the resources. Until this period, no attempt was made to analyze the quality and effects of the resources by the department. A faculty member mentioned this issue as:

Bu malzemeler hazırlanıyor ama yani hazırlandığı gibi kalıyor. Onun sürekli geliştirilmesi, feedback almak öğrenciden, ne kadar yararlı oluyor, geliştirilmesi bu konuları pek yapamadık yani. Hiçbirimiz de gidip de orada gerçekten bu materyallerin daha yararlı olması için emek koyamadık. Koyarsak olur tabi (P #1)

These materials are prepared, yes, but they are left unfinished. They always need to be improved. It's very beneficial to receive feedback from the student and improve it accordingly, but we couldn't. None of us put real effort on *bettering these materials. Of course we might have good consequesnces if we do (P #1)*

Until this time, the only data came from the feedbacks from the personal communication with students and instructors' perceptions and beliefs about the resources. Therefore, these personal and disorganized feedbacks from students might lead the instructors to have false impression about the resources.

4.3.2.4 Organizational Issues

4.3.2.4.1 Sustainable Practices in the Course

The faculty members who were responsible for the general chemistry course could be changed in each year but there was not a mechanism to inform the faculty members or the teaching assistants about the new practices and developments in the course. In addition, whether the current instructors were familiar with the new practices, they did not transfer the information to future instructors (N=3). Therefore, new instructors generally continued with the traditional teaching methods in the laboratory course. One of the faculty members argued this issue from his experience:

Yani şöyle ben kendi açımdan söyleyeyim, yani ben hep genel kimya vermiyorum. Mesela bu materyallerin hazırlandığı sırada ben bu dersi vermiyordum. Başladım, var olan bir sistem yani ben çok da farkına varmadım. Yani kimler katkı koydu? Yaparken amaç neydi? Nasıl hazırlandı? Yani geçmiyor hani sistem bir kişiden öbür kişiye aktarılarak geçmiyor. Ama nasıl oluyor? Mesela textbook var, text bookta tanımlı bir şey var. Alıp onu uyguluyorsunuz derste ama öbür tarafı ona bağlamak, yani nereden öğreneceksiniz? Yani orada bir kopukluk oluşuyor. Yani dersi veren hocalar sürekli değiştiği için ders içinde oradaki değişiklik yeni gelenlere bana öyle oldu mesela (P #1)

Well, personally, I don't always give general chemistry lectures. I wasn't giving this course when these materials were being prepared. I started with an existing system, so I wasn't very aware of who contributed, what the purpose was, how it was prepared. I mean you can't transfer the system from one person to another. But how can we do? For example there are textbooks, and there are things defined in the textbook. You take the book and apply it in the class. But how do we learn how to relate this to the other side? So there is a flaw. I *mean, as the lecturers always change, the change in the lessons has never been reflected to the newcomers. That was the case for me (P #1)*

Moreover, there was no place to inform new faculty members about the new practices. The guidance from the department or faculty members with verbal or printed resources was determined as insufficient for new faculty members.

4.3.2.4.2 Decision-Making Process

Derived from the observations, there were too many faculty members and teaching assistants in Chemistry Department, which leaded some difficulties for meeting in a common ground for some decisions. The environment in the department was democratic that they mostly worked in cooperation but for some practices, it took a long time to begin to act (N=3). One of the research assistants shared her memory about the resources:

> *Bir kere hatırlıyorum bir toplantı, bizim İnci Hocamız diye bir hocamız var o ilgileniyor zaten bu ara toplantılar falan. Bir kere bir toplantıda dile gelmişti sanırım hani bu ocw yi kullansınlar ne yapalım nasıl yapalım falan şeklinde ama oradan da bir sonuç çıkaramadık özellikle. Çünkü hani öğrencilere izleyin gelin deriz izlemez. Hani şunu da okuyun gelin diyoruz okumuyorlar gibi. Bir dayatmada kesinlikle yapamayız zaten öyle bir şeyde yok ama belki dediğiniz gibi daha ön plana çıkarılabilir. Belki daha üzerine yoğunlaştırılabilir. Belki bir şekilde daha etkili olması sağlanabilir (TA #2)*

> *Once I remember, we had a lecturer named İnci who is dealing with the meetings and stuff nowadays. I guess in a meeting she mentioned something like "they should use the ocw once, and let's see what we can do". But we couldn't come up with a solution here, too, because you know we tell the student to come to the classes having watched the videos but they won't just as they never read what they are assigned with. We can't also urge the student to do anything, but as you say it could at least be highlighted. It could be focused more upon. Maybe this way we can make it more efficient (TA #2)*

Beside the problems in decisions, the researcher attended the annual meeting for general chemistry laboratory course between two semesters. At the beginning of each semester, the teaching assistants met to discuss the current environment and problems in the laboratory. In this meeting, the responsible faculty member only mentioned the resources and wanted to open a discussion about the practices about the resources. In addition, the researcher presented some information about the resources but not many teaching assistants interested in the resources and they did not spare much time for this discussion. They did not make any common inferences and they turned into their major problems about the resources. Except the teaching assistant who mentioned this meeting above, other assistants even did not remember this discussion about the resources.

In addition, the faculty members did not comprehensively discuss the resources at the meetings so that they have had not a complete and agreed policy practices about the resources yet.

> Interviewer: *O zaman siz bunu bölüm olarak desteklediğinizi düşünüyorsunuz.*
>
> Interviewee: *Yani onu söylemek zor, biz en azından bir malzeme var yapalım ama bu desteklemek, yenisini yapalım sorusuna cevap olmayabilir.*
>
> Interviewer: *O konuda neden?*
>
> Interviewee: *Onu kurulda konuşmamız lazım. Yani herhalde hayır denmez ama başka benim şu anda göremediğim sakıncalarını ortaya koyabilecek kişiler olabilir yani biz genelde çok demokratik bir bölüm aslında burası hani kendi içimizde baya tartışırız, en son tamam falan. İşte eğrisiyle doğrusuyla tartışmamız lazım. Ben dediğim gibi pozitif bakıyorum ama o gün gerçekten çok iyi bir argüman koyarlar ortaya, bunun bir süre daha geciktirilmesi gerekliliği ortaya çıkabilir ya da belki de hiç düşünülmemesi onun için bir şey söyleyemem. Öyle bir şey olabileceğini de zannetmiyorum (P #2)*
>
> Interviewer: *So you think you support it as the department.*
>
> Interviewee: *Well it's hard to say that. We say that at least there is material but supporting doesn't meet the requirements to make the new one.*
>
> Interviewer: *Why?*
>
> Interviewee: *We need to talk about it in the commission. I don't assume they will reject but there might be people who would set forth the flaws that I can't foresee now. We are actually a democratical department; I mean we discuss everything together. So we need to have a thorough discussion about this as well. So I am positive about this as I said, but if they come up with a good argument against it, the decision could be a postponement or cancelation of this system altogether although I don't assume that would happen (P #2)*

4.3.2.4.3 Financial Support

Another problem about the organizational issues was financial support. Chemistry Department actually suffered from the lack of financial support from the institution. In the meeting with faculty members, they declared that the institution could not provide any technical improvements for laboratories. In addition, the department did not have any renewal for the equipment and materials in the laboratories. One of the faculty members highlighted this issue as follows:

> *Bölüme tabii ciddi bir yük oluşturuyor, tamam bunlar ufak makinalar gerçekten pahalı değiller ama hani bölümün de bütçesinin aslında bir avuç pirinç olduğunu ve her tarafa çekilip bir şey kalmadığını düşünürsek bunlar için tamam öncelikli ama ilk önceliklerimiz de değil daha sıralarımız çok kötü onları değiştiremedik gibi rektörlüğümüzü de sıkıştırdığımız çok fazla konu var, bu da onlardan bir tanesi, hani bize destek verin laboratuvarlara şunları alalım, bunları alalım, talebimiz var ama ne zaman yaparlar bilmiyorum (P #2)*
>
> *Of course it puts a big burden on the shoulders of the department. Ok, they can be small machines, which are not very expensive, but let's not forget the fact that the budget of our department is so small and we have other priorities. Our desks are too old, for instance. We need to replace them. So we rush the rectorship for many needs. And this is one of them; we ask for some financial aid for our labs, but I don't know when they can deal with it (P #2)*

In the meeting, faculty members also declared that they wanted projection for the classes in order to carry out some practices to use the resources but they could not even took any support for them.

4.3.2.4.4 Lack of Communication on Information Channels

The last problem in organizational issue was about the lack of communication. Some participants mentioned that they did not have an active information channel for laboratory course. One of the students criticized this issue from his experience as:

> *Mail ile bilgilendirmede kimya bölümü ile ilgili bir sıkıntımız var zannedersem. Mesela fizik bölümünün mailleri sürekli çok bilgilendirme mailleri atıldığı için genel olarak koordinatör tarafından hani fizik bölümünden gelen maile ben açıp bakıyorum. Çünkü sürekli bana bir bilgilendirme ama kimya bölümünden*

> *bugüne kadar İrem Hocadan bir make-up olduğunu ya da sınav zamanı sınıfıma bakmak için mail alıyorum. Onun haricinde genel bir bilgilendirme maili kimya bölümü adına hiç almadım. Hani böyle olunca kimya bölümü ile ilgili bir mail alınca çok dikkat edip bakmıyorum. Herhalde zaten göndermiyorlardı. Gönderdiklerinde de çok ilgilendiğim bir şey olmaz diye düşünüyorum (SMI #8)*
>
> *About informing by e-mail, we have problems in chemistry department as far as I'm concerned. For example when there is e-mail from physics department, I open it because too many notification e-mails are sent by the coordinator. But from chemistry department, I only get e-mails from Irem Hoca, and they're about make-up classes or notifications about my classroom during the exam term. I've never got any notification e-mails from chemistry department except for them. That's why I don't pay attention to the e-mails when they are sent from chemistry department, which probably they've never sent. When they do, I don't think it's something I am very interested in (SMI #8)*

After the two semesters in data collection process, a coordinator was assigned for this course in order to inform students about the activities in the course. This coordinator was also responsible to make announcements about the resources but the quality of these practices could not be evaluated for this research.

4.3.3 Desired Strategies-Practices

4.3.3.1 System-Related Practices

Two practices were provided in this part related with the system-related issues in department support section.

4.3.3.1.1 Attitude toward General Chemistry Course

As mentioned in many parts in the results section, one of the major concerns about the system was the lack of interest of students, which was derived from their attitudes towards the course. Any significant and organized attempt was made during two semesters to change this attitude towards the course and insufficient suggestions were provided also. One of the faculty members clarified this issue from his experience about this issue:

Çok yani gerçekten yeni nesille iletişimde ne yapmamız gerektiği konusunda çok zayıfız bir önerin varsa çok memnun oluruz. Çok böyle sıkıntılı bir şeydeyiz. Asistanlarımızdan yardım istiyoruz, onlar bir şeyler öneriyorlar, deniyoruz işte Whatsapp'ıydı Facebook'uydu türü şeyler ama onlar da bizle böyle etkileşmeyi pek tercih etmiyorlar. Herhalde kendi içlerinde etkileşiyorlar falan ya da biz onların o takip ettiği sayfalar gibi şeyler yazamadığımız için bilmiyorum. Öyle şeyler olabilir belki. Arıyoruz yani ilgi nasıl uyandırabiliriz. Çünkü biz üçüncü sınıf yerine onları birinci sınıf en azından birinci sınıfın sonunda uyandırabilirsek bizim açımızdan çok etkin olur. Yetiştirme ve işte ilgi beceri donanım açısından mezuniyetlerini bunun için bayağı aslında bunun için çaba harcıyoruz yani bu yaz yaklaşık ilk beş yüzün hemen hemen hepsini inceledik üniversitelerin ekipler oluşturduk. Onlar niye neler uyguluyorlar da biz de eksiklik var falan açıkçası çok da elle tutulur bir şey bulduk desek de yalan olur ama bakıyoruz ama bir şekilde yeni nesli de sürekli dinlemeye çalışıyor nedir eksiklik diye ama gördüğüm benim en büyük şey gelirken tercihten çok istekli gelmemeleri o da işte lablara yansıyor bu tür şeyler belki birazcık onların hani ilgi olmasa bile birazcık hazırlıklı biraz daha başarılı olmasına faydalı olabilir (P #2)

We really fail at how to get ahold of the young generation. We would be pleased if you have something to suggest. That's a big problem for us. We ask our assistants to help us, they try to give ideas such as WhatsApp or Facebook. But the students don't prefer having an interaction with us. It's maybe because they interact with each other, or we cannot write similar things as the websites they follow. We are looking for solutions on how to draw their attention. If we can at least enlighten them in the first grade, even the end of the first year, not the third, then it can be efficient for us. We make a big effort for their training, their interest and skills. For example this summer we analyzed almost all of the best 500 universities, we set up teams to find out what they do, how they manage but we frankly couldn't come up with concrete findings. But we still listen to the new generation, try to identify the defects. But what I observe most is that they are unwilling to study here, so it reflects to the labs somehow. This may at least be beneficial for them to be more prepared, more successful, even if we can't draw their attention (P #2)

As explained by the faculty member, they did not have a common approach to change the attitude and interest for the course yet. They only pointed social media to increase the communication at least with students. In addition to that, some participants suggested providing different experiments for different departments based on their future profession. One of the faculty members explained this issue in his quote below:

Ama şöyle yani bu özellikle mühendislik çok kalabalık. Oradan çok öğrenci geliyor. Onların ilgi alanlarına yönelik deneylerin tasarlanması biraz daha farklı boyutta deney yapılması söz konusu olabilir ama onun için de kaynak ayırmamız lazım. Yani laboratuvarın düzenlenmesinden tutun da yeni deneyler yani bizim yaptığımız deneyler gerçekten elden geçebilir. Daha böyle birtakım aletlerin kullanıldığı şeyler olabilir. Daha sınırlı, daha iyi deneyler tasarlanabilir. Özellikle mühendislikten gelen öğrencilerin ilerde de kullanabileceği, analizlerin de yapılabileceği bazı şeyler koyulabilir (P #1)

Well, the thing is, especially engineering department is too crowded. There are too many students coming from there. It may be possible to design and carry out different experiments in accordance with their area of interest but we need to spare some sources for that. I mean for example, the labs can be re-organized; the new experiments I mean our experiments can be revised. We can use some tools. More limited, but more effective experiments can be designed. Some substances that the students from engineering departments can also use and analyse in the future can be added (P #1)

Related with this issue, one of the teaching assistants also suggested removing some laboratories for some departments, which could help the instructors to save their time for different subjects:

O zaten var. Hani ben onu da söylüyorum, bazı bölümlere vermeyelim lab. Zaten çocuğun hiç ilgisini çekmiyor ki. Yani ne bileyim bilgisayarcılara falan hani çok gerek yok laba diye düşünüyorum ama onu da işte kabul etmiyorlar pek, ders veriyorsak labı da verelim falan diye (TA #9)

We already have it. I mean I say it as well. We don't have to give labs to some departments. The students are not interested in after all. I don't think computer engineering students need the lab at all, but they don't accept it. If we give the lesson, we should give the labs, too. That's what they think I guess (TA #9)

In addition to some organizational suggestions, instructors made some personal approaches during the experiments:

Bence şey olması gerekiyor, öğrencilerin hevesinin artırılması için bazı çalışmalar yapılması gerekiyor. Yani bunun için çok bir fikrim yok şu anda çok düşünmedim ama hani belki bu genel asistanların tavrı ile alakalı bir yorum, sizin çalışmanız ile çok alakalı değil ama bazı asistanlar çok zorlaştırıyorlar. Hani zorlaştırmaktan ziyade hani hep birlikte buraya toplandık gelin şunları görelim tarzında bir yaklaşım bence daha mantıklı olacak ki şey çok daha küçük oldukları için asistanlar ile ilişkileri ne kadar iyiyse o kadar ilgili oluyorlar (TA #2)

I think we need to do something to encourage the student. I haven't thought about this enough, I don't know how, but maybe this is more about the asissstants' attitude than your work, but some of the assistants make it really hard. Well instead of making it harder, there must be such an approach as "let's come together and see this and that". You know as they are very young, the better they get on with the assistants, the more interested they will become (TA #2)

4.3.3.1.2 Interrelation between Faculty and Laboratory Course

The connection between the faculty member and laboratory course was important to manage the course system. Whether the teaching assistants were responsible for the laboratory, the connection between the laboratory and main course was in charge of faculty members. Therefore, the lack of communication between two components also affected the quality of the system. Regarding teaching tradition in the laboratory environment, one of the faculty members suggested to increase the interaction with the students and the system as:

Hem hocaların kendilerini sorgulaması hem öğrencinin kendisini sorgulaması onu yapacak biçimde gidebilirse hani sizin de mesela feedback vererek yapılan iş işe yarıyor mu yaramıyor mu, feedback vermek, onu da soruyla sağlamak mümkün. Yani daha devamlı hale getirmek, sürekliliği sağlamak bir taraftan öğrenciye gidip şey yapmak, öğrenciyle ben bunu genellikle yaparım dönemin sonuna doğru laboratuvarla ilgili şeyiniz nasıldı diye öğrenciyle paylaşırım ama daha sık yapmak gerekiyor olabilir. Hoca, öğrenci belki sizin gibi eğitimciler her iki tarafa bakabilen ve verilen cevapları paylaşarak daha iyi olmasını sağlamak iyi olabilir (P #1)

It could be done by both self-critics of faculty members and students like your attempt to find the effect of ıt by giving feedback and questions I mean we may need to make it sustainable by asking their opinions about labs, which I do generally at the end of the semester, but obviously, I need to do it more often. It could be better if educators like you or lecturers and students who have the perspective on two sides of both, and it could be improved by sharing the answers the students give (P #1)

In addition to the suggestion above, some faculty members tried to associate the course content with the experiments in the laboratory. He aimed to encourage students to make some inferences about the course.

> *Ben daha sonra derste işlersem aslında deneye de refer ederek böyle böyle böyle bakın yapmıştınız, şöyle olmuştu, şöyle şöyle sonuçlar çıkmıştı, çıkması gerekiyor en azından ya da şunu şuna karıştırdığınız zaman şöyle olması gerekiyor hani bunun için yaptınız gördünüz mü, kaç kişi gördü? Onları da orada birazcık etkileştirmeye çalışıyorum ya da en azından vurgu yapmaya çalışıyorum (P #2)*
>
> *I try to activate the students or at least emphasize some points by refering to the experiment saying "see, you did this, and this happened consequently; it was supposed to result in this; you will have this if you mix this with that. I am trying to activate them or to highlight at least (P #2)*

Regarding the interaction with the students and feedbacks about the system, one of the students suggested forming a platform to interact with the faculty members about the experiments.

> *Bir ders gibiden ziyade mesela şey olabilir, videoları izliyorsunuz, simülasyonları uyguluyorsunuz, soru çözerken aklında kalan şeyleri mesaj atabileceğin bir platform oluşturulabilir. Daha o konuda böyle ilgili olan insanların cevap verebileceği (SMI #18)*
>
> *Rather than a course, it could be something like, you watch the video, apply the simulations, create a platform that students can use to text to ask questions when they have difficulties and get answers from people who are more related (SMI #18)*

4.3.3.2 Resource-Related Practices

4.3.3.2.1 Advertising Practices

Based on the results of the questionnaire, 65.3% students were aware of the OERs. The channels for awareness were showed in Table 4.4 below.

Table 4.4 Information channels for students to aware of the OERs

Information channels	*f*	%
Brochure	10	5
Friends	94	47.2
Teaching assistants	99	49.7
Faculty members	8	4
News	1	0.5
Other	15	7.5

As seen in the Table 4.4, nearly half of the users were aware of the OERs by the teaching assistants and their friends. However, in here, it was important to discriminate the target departments (METE & MINE), which were informed by the researcher who was also seen as a teaching assistant by the students in the course. Therefore, regarding the departments, the frequency of awareness of the OERs and the information channels were also reported in Table 4.5 and Table 4.6 respectively.

Table 4.5 Frequency of awareness by departments

Department	Awareness	
	Yes	No
METE	49	11
MINE	34	15
GEOE	33	20
PETE	17	15
GENE	18	19
CHE	46	34

As seen in Table 18, more than half of the students were aware of the OERs in the departments of METE, MINE, GEOE and CHE, whereas the students in two departments (PETE, GENE) were less informed groups. On the other hand, regarding Table 19, especially the METE & MINE groups had higher frequencies for getting information from teaching assistants while in other groups the friend factor was selected as the highest information channel. In addition, the faculty members had minimal impact on advertising issues for OERs, similarly the brochure was seem ineffective for advertisement.

Table 4.6 Frequency of information channels by departments

Department	Information Channel					
	Brochure	Friend	Teaching assistant	Faculty member	News	Other
METE	5	12	33	1	1	6
MINE	2	15	20	3	0	0
GEOE	3	18	13	2	0	3
PETE	0	12	5	2	0	1
GENE	0	6	12	0	0	1
CHE	0	31	17	0	0	4

In correspondence with the results of the questionnaire, the results from the qualitative data were provided in the following sections below.

4.3.3.2.1.1 Brochure-poster

Most comments about the brochures, which were distributed inside the university, had a negative influence on students. They mostly described the brochures as ineffective to inform the people. Too many brochures were distributed inside the university so that they ignored the information inside the brochures. One of the students explained this issue as:

> *Okulda çok fazla broşüre, afişe maruz kaldığım için çok fazla ilgimi çekeceğini zannetmiyorum ki çok fazlada zaten duvarda duracağını da zannetmiyorum (SMI #8)*

> *I don't think it would draw my attention, as there are already too many brochures or posters at school. Plus, I don't assume it would stay long on the walls (SMI #8)*

Contrary to brochures, the participants were more positive about the posters. Nearly half of the participants found them as ineffective as brochures but the other participants described the potential attractive environment of posters. However, in order to attract people, they should be designed to trigger the people's curiosity and interest. A student emphasized this issue in detailed:

> *Yani ama böyle ama afişlerde etkileyici şeyler kullanılmalı bence yani hani eğer bu herkesin anlayabileceği yani herkese açık bir sistemse mesela yani hani anlamadıysanız hani vurucu slogan denir ya anlamadıysanız bir de buradan deneyin falan gibi birşeylerle insanlar illa ki açar çünkü ODTÜ öğrencileri meraklı yani hani açar bakarlar çünkü herkesin anlamadığı bir şey oluyor ve işte insanlar anlamayınca işte ne yapacağız falan hani ODTÜ öğrencisi anlamadığı şeyin peşine düşer yani hani o yuzden öyle bir şeyin varlığını bilseler kesinlikle kullanır yani (SME #5)*

> *But I think they should use impressive elements in the posters. It can be something that everybody can understand. For example, they can use such strong slogans as "try this if you didn't understand". I believe they will check it out eventually, because METU students are really curious. You know, after all everybody has something they don't understand, and people, especially*

METU students will definitely hunt down on what they don't understand. So they will certainly use it if they know such a thing exists (SME #5)

Another suggestion for the posters was to provide them inside and outside the chemistry laboratory environment. This strategy could help to inform the students in their learning environment. One of the students described this situation as follows:

Broşür, afiş labda olursa mesela, labın girişinde olursa öğrencilerin direkt labda baktığı yerlerde olursa işe yarar, dışarıda olursa hiçbir işe yaramaz, her yer afiş çünkü zaten (SME #14)

It would be effective if the brochures and posters are at the entrance of the labs where the students can directly perceive when they look at the lab's door. I don't think it would be useful outside as there are posters everywhere already (SME #14)

However for the sustainability, both brochures and posters could not sustain the permanent use of resources, they only provided information for the first users of resources. In addition, some students also suggested adding information about the resources on laboratory book, which could attract students' attention more.

Kitaba yazılabilir. Bu deneyi, bu sitede şu sayfada görebilirsiniz, ayrıca izleyebilir yada simülasyonla şey yapabilirsiniz diye. Çünkü gelmeden önce herkes kitaba bakıyor (SMI #11)

It can be written on the textbook like "you can view this experiment in this website and watch and apply via simulation." because everybody checks the textbook before they come to the labs (SMI #11)

4.3.3.2.1.2 E-mail

One of the most emphasized practices to enhance the awareness about the resources was sending e-mails. Participants were generally positive about receiving e-mails about the resources. As mentioned before, at the beginning of each semester, two groups were informed about the resources via e-mail by the researcher but while experimental group was informed in each class, another group (control group) was sent e-mail only before 4th class. E-mail only contained brief information about the resources. A student from the first group mentioned that e-mails were effective to recall for the use of resources:

Evet oldu çünkü ben bazen unutuyorum mesela bakıyorum aa iste Seçil hoca mail atmış bir bakayım falan diye bir hatırlatma oluyor (SME #9)

Yes that happened. For example sometimes I forget and I check my e-mails saying Seçil Hoca sent an e-mail. So it's something like a reminder for me (SME #9)

In the second class, a mini-talk was arranged with students while they were doing the experiments in order to get some feedback about the resources. Some students complained that they could not find the location of the resources in the website. Therefore, the content of the e-mails were changed and the links of the resources in the website were provided for both videos and simulations. After second week, most of the students did not have difficulty to use the resources.

Regarding second group of students, they mentioned that if they got an e-mail, they would use the resources at least. A student expressed her perception in the following comment:

Mesela evet her hafta bilgilendirme maili gelse hı tamam deyip gerçekten bakabilirim tam labdan önceki gün falan böyle tamam ya evet bakmalıyım falan derim (SMI #5)

For example, if we are sent a notification e-mail every week, I can check my e-mails frequently especially the day before the lab (SMI #5)

However, the major concern about e-mail strategy was possibility to decrease the studying responsibility of students. Some participants argued that e-mail could be effective for the information but it could provide an artificial process for sustainable use of resources. A teaching assistant explained her concern as:

Aslında işe tabii ki yarar ama şuna da karşıyım yani biraz da kendi sorumluluklarını kendi bilmesi gerekiyor yani sürekli izle şu var takip etmek hatırlatmak yani nereye kadar ve o sorumluluğu kendisi alması gerekiyor (TA #6)

Yes of course it works, but I am also against the idea that we should always push them to follow, remind of everything all the time. I mean they must take some responsibility and follow their work as well (TA #6)

4.3.3.2.1.3 Recall by faculty

The third highlighted practice for advertisement was recall by faculty. Most of the participants mentioned that the teaching assistants and faculty members did not inform them about the resources.

> *Yani kimya hocasının bir duyurusu olmadı onun dışında hani diğer derslerde de bir duyuru olmadı ya siz, sizden önce ve sizden sonra diyebilirim yani (SME #1)*

> *Well, the chemistry teacher has not made an announcement; also we didn't get any information in the other lessons either. Well I can only say the announcements before and after you (SME #1)*

However, some participants were aware that one of the teaching assistants gave brief information about the resources but they did not found this strategy sufficient to provide information about the resources. In addition, both teaching assistants and students claimed that it could be more effective to inform the students by faculty members. A student in the following comment clarified this statement:

> *Belki mesela kimya dersinin kendisinde hoca söyleyebilir bunu bildirebilir ya çünkü hani hocanın söylemesi var bir de hani bölümle ilgisi olmayan birinin yani sizin daha doğrusu mail atmanız var ya da sizin söylemeniz var hani ders hocası direk söylese mesela aa dersin bu dersin bir bölümü hani dersle ilgili bir şey bu o olabılır (SME #4)*

> *Maybe in chemistry lesson, the lecturer can announce this personally, because you know there is a difference between your announcing or e-mailing this as somebody not related to their lesson and when the course's lecturer announces it. If the lecturer of the course makes the announcement, the student will definitely take it seriously as it is something related to the lesson (SME #4)*

In addition, the teaching assistants were eager to give information about the resources but they similarly thought that the faculty members had more effects on students' perceptions and behaviors.

4.3.3.2.1.4 Social media

Beside some effects on social and personal life, there is a trend to use the social media for academic practices. Some participants emphasized the power of communication through social media and its power on advertisement. A teaching assistant represented this perception in her statement:

> *Şimdi zaten mailden ziyade facebook falan o tarz bir sayfa açılabilir genel kimya bilmem ne laboratuvarı diye çünkü insanlar o tarz şeyleri daha çok kullanıyor. Mesela ona üye olabilirler, asistan o hafta ne deneyi yapacaksa atabilir ya da kim yapacaksa hani facebookta dolaşırken şu da videoymuş diye açıp bakmak daha kolay olabilir yani (TA #1)*
>
> *Rather than mail group, a Facebook page like "general chemistry blah-blah lab" can be opened as students use those pages more. They can be the member of that group and get informed about the topics and experiments. Also they can encounter some videos as they scroll down. It may be way easier (TA #1)*

4.3.3.2.1.5 Website announcements

Regarding the website announcements, participants complained about both university and department's homepage. For the university's homepage, any information was provided about the OCW website so that the information could be given in visible and attractive format on homepage.

> *Nasıl desem daha çok reklam verilebilir reklamdan kastım mesela ODTÜ' nün ana sayfasına girdiğimiz zaman köşede görünebilecek bir yerde hani göze çarpabilecek bir şekilde OCW şeklinde daha böyle hani allah allah bu neymiş diye millet tıklar ordan görür yani (SMI #1)*
>
> *Also, they can place an advertisement at a visible corner of for example the home page of METU website with the ocw symbol. So students may want to check the link out of curiosity (SMI #1)*

In addition, the link for the resources was provided in Chemistry Department website under *Quick Links* section but some participants did not find this strategy efficient because it was not in a position to attract the people's interest. In addition, students barely used the Chemistry website through their course process. Thus, some participants offered another strategy to increase the awareness about the resources.

> *Yanı en cok kullandıgımız bazı sıtelerle ılgılı bır mesela metu onlıne a bır reklam gıbı bır sey gecılebılır general announcement... onun dısında benım ..yanı cunku acıkcası okulun cok fazla sıtesı var aslında ama cogumuz bılmıyoruz bu sıtelerı bıze pek haber veren de olmuyor acıkcası ama dedım yanı en cok kullanılan sıtelerle ogrenebılırız yanı metu onlıne de (SMI #7)*

Well something like advertisement, general announcement links can be added to the most popular websites like METU online. Actually, the school has many websites, but we're not aware of them much and no one inform us about these websites. But as I said now, we can learn it online through popular website lıke METU online (SMI #7)

For this suggestion, a faculty member expressed that he shared the links under metu online years ago but he did not check or update them.

4.3.3.2.1.6 Presentation during the class

Some participants suggested showing the resources before the first class to increase the awareness about the resources. Regarding this suggestion, it was important to describe the possible benefits and effects of resources for the first users. One of the students explained this suggestion in her comment below:

Ama ıste ocw ne bunlar ne yapar falan dıye daha once kullanmamıs bır ınsan olsaydı emınım cok da bakmazdım sanırım once bırazcık bunun ne oldugunu tanıtmak gerekıyor hanı ya evet ocw var hadı gırın bakın demek degıl de burda sunları yapabılırsınız bu sızın ıcın sunu yapmanız ıcın yanı fayda saglar gıbı bır bılgılendırme gerektırebılır (SME #9)

But, if I hadn't used ocw before, I wouldn't check what it is and what it does. So I believe, it needs to be made widely known. Rather than just saying "there is ocw go check it out" you may have to explain what the students can find there, that it would be beneficial for them in this or that way (SME #9)

In addition, one of the teaching assistants portrayed the potential practice of the presentation in the following comment:

Tanıtım toplantısı video ile yani şöyle, şöyle deneyler ile uğraşacaksınız, genel kimya labı budur. Şöyle bir labdır. Şu deneyler yapılacak öyle bir genel ve orada da o videolar kullanılabilir kısa, kısa. O zaman aa ne güzelmiş falan ilgisi yaratıp, ondan sonra her deneyden önce o teşvik olur. Oradan bakarım diye yer edinmiş olur yani beyinlerinde (TA #6)

The introduction meeting can be made via a video which briefly explains what kind of experiments the student will encounter, what is general chemistry, what experiments will be carried out. Then you grab the student's attention before the experiments. The students learn that they can check the experiments from the website (TA #6)

4.3.3.2.2 Encouragement practices

There were many motivation and encouragement factors, which affected the students' use of resources as mentioned in the use section. Therefore, the students' usage profiles basically shaped by these factors so that in order to encourage students, some practices could be applied based on these factors. One of the faculty members claimed these factors as:

> *Yani şöyle olması lazım. Öğrenci emek koyduğu zaman onun karşılığında bir şey alması lazım. Puan mı alır yani bir ödülü olması lazım. Biz genellikle koyuyoruz ama ölçmüyoruz. Yani kullanıyor mu kullanmıyor mu? Kullanan oradan bir menfaat sağlıyorsa öğrenci hep ona bakıyor. Ekstra bir zaman çünkü. Ekstra zamanı koyarım ben bundan ne sağlarım. Hiç sağladığı bir şey yoksa bakmayanla bakan arasında bir fark yoksa bakmıyorlar. Çünkü zaman o, yapmıyorlar (P #1)*
>
> *Well, it should be like this: when a student makes an effort, s/he must get something in response. A grade or any reward. We generally add this but we don't evaluate if the student uses it or not. Those who use will always use it if they profit from it somehow. As it requires extra time, the student wonders if it's waste of time or does any good for him/her. If there is no difference between those who always follow the website and those who don't, then students stop using it because time is important (P #1)*

Regarding these factors, some suggestions were offered by participants in order to encourage students to use the resources.

4.3.3.2.2.1 Peer encouragement (Social influence)

Regarding first encouragement, students were influenced by their peer's perceptions and opininons about the resources. Some participants mentioned that they could be motivated to use the resources according to the people's behaviors and ideas in their environment. The dialogue between the student and the researcher aimed to clarify this issue:

> Interviewee: *Ek puan kazansam, kesinlikle yani % 99 şey yapardım ki hani herkes yaptığı içinde yapardım. Ek puanın derdine düştüğüm için değil. Ek puan olsa herkes yapardı. Bende niye ben yapmıyorum diyip, herkes yaptığı için yapardım. Sürü psikolojisine girebilirdim.*

Interviewer: *Peki, herkes yapmasa diyelim?*

Interviewee: *Herkes yapmasa, benim çevremdeki insanlar yapardı büyük ihtimalle. Sonuçta muhabbeti dönerdi. Bir hafta girmesen, sırf geçen hafta puan kaybettim bu hafta gireyim diye bunu ek puan olarak değil normal puan olarak görürdü herkes. O yüzden şey yapardı herkes (SMI #9)*

Interviewee: *If I had got the additional point, I would 99 % make it, as everybody did. It's not because I am concerned about the additional point. Everybody could have done it with additional point. And I would do it just because everybody else did. I could have got into mob mentality.*

Interviewer: *So what if not everybody does?*

Interviewee: *Even if nobody does, people around me would do most probably. We would at least talk about it. If we don't attend one week, we would definitely try not to miss the following week. I mean we wouldn't perceive this as an additional point but a regular point. So everybody would try to attend (SMI #9)*

4.3.3.2.2.2 Bonus point

As mentioned before, grade was a motivator for using the resources. Regarding encouragement, some participants agreed to be given bonus points, which could increase their motivation to use the resources. They thought that the students were motivated by some rewards or conditional situations but the final acquisition could be beneficial for learners. One of the students explained her idea about this situation as:

Bence olabılır yanı sısteme hanı logın olup ogrencı numarasıyla mesela ıste 1 puan 2 puan neyse vıdeoyu ızleyıp vıdeoyu bıtırıp tamam ıste puanı aldıgınız gıbı bır sıstem guzel olabılır tamam evet bıraz zorlama olacak ama en azından bırcok ınsan bunun faydasını gorecektır (SME #9)

I think it could work. I mean, the student can log in to the system with her student number and for example, she could watch the video until the end and whatever the point would be; she could get one or two points. Alright, it could be a good system when you get those points. It would be a bit HARD but at least lots of people would be able to benefit from this (SME #9)

On the other hand, whether most of the students were satisfied with the bonus point idea, many of them did not argue to use grading for the use of OERs. They thought that this strategy could be coercive situation for them. They also supported that the rewarding could not be derived from the external factors, it should be internal for them. One of the students explained this situation more detailed in his comment:

> *Eger amacınız ogrencıye daha fazla kullandırmaksa kesınlıkle notun bır etkısı olacaktır ama bunun notla degerlendırılmesını de sahsen takdır etmem. Ögrenmek ısteyenın kullanması gerektıgını dusunuyorum ogretıyor da aynı zamanda. Eger dogru duzgun yapılabılırse hanı bunun zaten bır not getırısı olacaktır hanı bunu bunu kullanmayla ayrıyeten bır not vermenın de anlamsız oldugunu dusunuyorum (SMI #3)*

> *If you aim to make the student use this system more, the grade will definitely be effective, but I don't think it is a good idea when they assess it by the grades. I like the idea that students who want to learn should use this; at the same time it teaches something. If it is managed properly, it will bring points. I think it doesn't make sense when it is graded separately upon using the system (SMI #3)*

In addition, the second problem about this issue also revealed the question of how the students' usage activities were followed. The students could login the website with their accounts, which could be determined by their names, but the problem about quality of the activities were still remained. The students could interest in other activities while the video continued to play in the background. Therefore, the rewards based on grading could not be reliable to detect the use of resources.

4.3.3.2.2.3 Popularity

Other encouragement was remarked as the popularity of the resources. Some students mentioned that they selected some online resources based on their popularity so that increase the awareness and popularity of the resources could be resulted in increase in use.

> *Bunu sadece ODTÜ'de değil, genel olarak kullanıldığını bilmek hani herkesi teşvik edebilir. Sadece okul içinde değil, bunun genel olarak popüler olması, herhangi durumda popüler olması, bunun kullanımını çok artırır. En azından benim için öyle olurdu yani. Çünkü herhangi bir Open Course 'u izlerken ODTÜ dışındaki, direkt yani insanların ne kadar izlediğine göre izliyorum, popülerlik de önemli yani (SMI #9)*

> *It could encourage people to know that this is used not only in METU but in other universities too. If it becomes popular, not just in the school but in*

general, in any ways, more people will start using it. At least I would, I mean. Because when I watch an Open Course out of METU, I watch it according to how many times people have watched that, so popularity is important as well (SMI #9)

4.3.3.2.2.4 Mobile applications

The last suggestion for the encouragement was to develop a mobile application to give some information about the course. One of the students mentioned his suggestion in the quote below:

> *Yani şimdi mobil uygulama olsa bir sonraki gün labım olduğunu hatırlatıcı vs. bu tarz şeyler yapılabilse ki telefondan bunu da artık çok rahat yapabilirim. Ben hani lab periyodumu girdiğim zaman benim haftaya hangi labım olduğunu söyler. Bende onun videosunu izleyip rahatlıkla girebilirim (SMI #8*)

> *So if there is a mobile application now which tells me that I have a lab course the next day etc., if it can do this kind of things, which I can do it very easily on my phone now, when I enter my lab period, it will tell me which lab course I have next week. And I can watch its video easily (SMI #8*)

Related with the advertisement and encouragement factors, participants were asked how the resources should be provided through the system: optional or mandatory. Small part of the participants thought that the students should be entailed to study on their courses, which a student explained in his comment below:

> *Optional olursa 100 öğrenciden 10 tanesi ancak kullanır. Diğerlerinin haberi vardır ama ya boşver gidelim derse kafası olur. Öğrenci çünkü rahat adamdır. Derse (26:49) derse gelmez. Optional verirseniz, yani derse gel veya gelmeden (26:54) Bunun gibi düşünürseniz bazı şeyleri kabul etmeniz lazım, optional yapamazsınız (SME #16)*

> *If it was made optional, 10 out of 100 students would use it. The others would know about it but they would say "Never mind, let's enter the class." because a student usually chills. You tell her to come to the class but she doesn't. You give them the option, like "Come to the class or study at home." If you think this way, you need to accept some things, you can't do it optionally (SME #16)*

On the other hand, most of the participants agreed to be encouraged to use the OERs rather than some obligatory practices. They supported that some students might not need to use them. A teaching assistant explained her perspective about this statement below:

> *Bence ekstra kaynak olarak kalması daha iyi çünkü ben her zaman için dayatmadan hoşlanana bir insan tipi değilim. Mecbur edildiği zaman mesela şöyle oluyor, prosedüre de sözde çalışıp geliyorlar ezberliyorlar anlamadan geliyorlar yani sonuçta ona çalışmak zorunda oldukları için ama bazı gerçekten ilgili olan çocuklar, oradan da okuyorlar, videoyu da izliyorlar. Hani bu birazcık onların sorumluluklarına kalmalı. Her şeyi biz üstlenmemeliyiz diye düşünüyorum (TA #1)*
>
> *I think it is better when it stays as an extra source because I personally don't like enforcement. When it is a must, for example this happens, the students act as if they have studied, they memorize it but they don't understand it, I mean they have to study for that eventually. But the some students who are really enthusiastic to learn read it on there too, and they watch the video as well. So they should be up to their sense of responsibility. I think we should not be responsible for everything (TA #1)*

Thus, some obligatory practices might not be beneficial for the students but the common perspective derived from the observations and interviews was to integrate the resources into the system.

4.3.3.3 Organizational Practices

4.3.3.3.1 Sustainable practices for the course

There was circulation among the faculty members who were responsible for general chemistry course. When the resources were first created and announced, only responsible faculty members were interested in the resources. Therefore, when these faculty members changed, new instructors were informed about these new developments. For this issue, one of the faculty members suggested employing a coordinator to inform the instructors.

> *Yani o hazırlanışın temel felsefesi neydi? Öğrenciye nasıl sunuldu? Nasıl öğrenciden feedback alındı? Mesela benim açımdan orada bir kopukluk var. Onu kim yapar? Nasıl yapılır bu? Yani bir genel kimya koordinatörü gibi bir şey olup da yeni gelenlere hakikaten bu sistemin şimdiye kadar yapılmış olan, nasıl yapıldığı aktarılabilse, böyle bir kopukluğumuz oluyor. Yani Kimse*

burada sabit olmuyor. Bir süre sonra oradan kopuyorsunuz, başka bir derse gidiyorsunuz. Bağlantı kopunca da daha önce ne yapıldığı kopmuş oluyor. Yani sizin sorduğunuz bazı sorular bana ilk defa yani öyle bir sorun oluyor (P #1)

So what was the basic idea behind that preparation? How was it given to the students? How was the feedback taken from the students? For example for me, there is a disconnection there. Who would do it? How is it done? I mean if a general chemistry coordinator came and told the new comers that this system was made and explained how it was made, we wouldn't have that disconnection. I mean, no one is steady here. After a while you disconnect and you enter a new course. When you disconnect, what have been made is gone. So the questions you are asking me, the first time, so this kind of a problem occurs (P #1)

4.3.3.3.2 Sustainable practices for the OERs

Since the resources were first developed, any improvement or update was implemented. While the faculty members and teaching assistants did not have much time and technical profession, the department was dealing with much important issues so that the resources was not an initial problem for the department. Therefore, in order to make some improvements about the resources, some suggestions were raised during the interviews. From the instructors' perspective, a working group could be attended to improve the resources:

İşte biraz videolara bakmıştım eksikleri çok. Yani işte seçti falan size de gelen şeyler var daha güzel de olabilir ama bunun için de para lazım onu da biliyorum, para var mı onu bilmiyorum:) Bunun üstüne emek harcamak lazım, açıkçası çok ekip olması lazım çünkü biz gerçekten çok meşgulüz. Üstünden şöyle bir hızla konuşup bir şeyler konuşup yapacak bir ekip lazım bunu. Çok üstüne gidebildiğimiz yok, asistanlara da yükleyebileceğimiz bir şey değil, bunun üstünde çalışacak birilerinin olması lazım. O şekilde bence çok güzel videolar çıkartılabilir. Daha önce de konuşmuştuk hani biz de zaten elimizde bulunan sayıyı hatırlamıyorum ama 20'nin üstünde kesinlikle 40 civarı olabilir bir hazır zaten malzeme daha çok lise öğrencilerine yönelik ama malzeme de var zaten. Çeşitlendirilebilir bunlar yapacak ekip olduktan sonra yani yapıladabilir (P #2)

So I watched the videos a bit and they have many deficits. It's like, there are stuff that is coming to you too, it can be better but money will be a need I know that too, I don't know if there is money☺ People should make an effort on this, *actually there must be a team because we are really very busy. There must be a team that has to talk quickly and do something for this. We can spend much time on it, and we can't give this responsibility to the assistants, there must be someone to work on it. I think that way, very good videos can come out. We talked about this before, I don't remember which number we have in our hands but it is over 20 definitely, it can be about 40, a sample material is more like for high school students but there are already some materials. They can be diversified; I mean when there is a team that can do it, it can be done (P #2)*

In addition to the suggestion above, an interdisciplinary approach could be followed to improve the resources as a faculty member emphasized in his comment below:

Ama bunların hepsi için koordineli bir çalışma çok iyi olabilir. Yani onların gelecekte kullanabilecekleri deneyleri koymak, ondan sonra simülasyonlar için sizlerle işbirliği yapmak, onların öğretim üyeleriyle işbirliği yaparak böyle bir şeyi tasarlamak mümkün (P #1)

But a coordinated work can be very good for all these. I mean adding experiments that they can do in the future, working with you on the simulations, it is possible to design such a thing by cooperating with their teaching staff (P #1)

While the OERs were being created, Chemistry Department worked collaboratively with *Instructional Technology Support Office* to get technical and instructional support. For future improvements, also the different departments could be included to design the experiments oriented by their students' interest and profession. However, for the general chemistry main course and other laboratory courses in Chemistry department, they were not eager to provide new resources. One of the faculty members described this issue from his perspective:

Bizimki zaten genel kimya malzeme olarak internette o kadar çok ki o tarz bir dersi videosuz vesairesiz animasyonsuz hazırlamak bir şeylerle uğraşmadıktan sonra zaten internet genel kimya bilgisiyle dolu. Diğer derslerde de yapılabilir hani üst derslerde de ama hani ne kadar olur ne kadar olmaz yapılacak şey gerçekten değer mi, izleyicisi ne kadar olur kısmı çünkü genel kimyanın marketi belli. Diğerlerinde belki biraz düşünmek lazım (P #2)

You can find so many of our materials on the Internet, it's easy to prepare a course without videos or such, without animations, the Internet is already full of chemistry facts. You can do it in other courses too like upper grade courses but I don't know how much it can be or if it is worth what will be done, how *many viewers there will be because the market of the general chemistry is obvious. Maybe one should think of the others (P #2)*

4.3.3.3.3 Lack of communication on information channels

Regarding the last strategy about organizational issues was to constitute a group for communication. For this strategy, also a coordinator could be assigned to arrange the information for students.

> *Benim kimya labında böyle kapalı bir grup kurulsa atıyorum, maden bölümü ile alakalı bizim lab koordinatörümüz ya da lab asistanımız tarafından kurulup, arkadaşlar bir hafta sonra yapacağınız deney budur, bu deney için size gerekli bilgi ve simülasyon budur denirse ki çok kolay bir uygulama ki grup kurmak ve gruba listedeki insanları eklemek artık çok kolay bir uygulama. İsminizi soy isminizi girdiği zaman gayet net üye olunabiliyor. Okul hesabıma mail gelmektense, facebook gibi bir gruba eklenip, takip etmem daha kolay (SMI #8)*

> *If, so to say, such a closed group is created, about mining department by our lab coordinator or lab assistant, if we say "Guys, this is the experiment that you will do next week, this is the information and simulation that you need for that experiment.", it will be very easy to create a group and add the people on the list. When you write your name and surname, you can be a member easily. It is easier for me to follow when I am added on a group like Facebook, rather than getting e-mails on my school e-mail (SMI #8)*

Most of the students complained about the information channels in Chemistry Laboratory course. Some students gave some examples from Physics Department, which was defined to provide a successful communication between students and department so that strategy could increase the interaction and adoption of the students with the course environment.

4.3.4 Institutional Practices

In addition to suggestions for the issues on department, some participants offered many practices for institution under three topics.

4.3.4.1 Generalize Sharing Culture

The first suggestion was to generalize sharing culture throughout the world. Most of the participants supported that the traditional education faced a change in people's learning styles and strategies so that sharing the information became more important in this new era. One of the students highlighted this perception in her comment below:

> *Çünkü eğitim artık tamamen hocalardan aldığınla kalmıyor, hiçbir üniversitede hiçbir şeyde bu böyle olamaz. Kendini geliştirmek, ilgi alanlarını daha baskın kılmak… Zaten bilgi çağında yaşıyoruz, bilgi kazanılıyor, biraz daha şey yapmak için artık… Çünkü kitaplar da bir yerden sonra güncellenmediği için yetersiz kalıyor. Ama internette videoyu güncellemen çok daha rahat. Teknolojiyi güncel olarak takip etmek için de önemli (SMI #18)*
>
> *Because education is not only what you receive from teachers anymore; it is not the case at any university. Improving yourself, strengthening your interests… We live in the information age; information is earned to do many more things now. You know the books are also insufficient since they are not updated after a point. But it is much easier to update a video on the Internet. It is also important in order to follow technology timely (SMI #18)*

The institutions played an important role for providing valuable and reliable information for people in the world so that the institutions had a pioneer role for new educational developments like open educational resources movement. Related with this perspective, one of the students explained in detailed why the institution should share the resources as below:

> *Yani materyallerin açık olması gerekiyor. Çünkü neden? İnternetin gerekliliği aslında o bence, internetin temel amacı o zaten kurulurken. Bence bunun olması gerekiyor. İnsanlar biraz daha o toplum içindeki bilgi seviyesi farkını da bu şekilde biraz daha azaltabiliriz yani. Çünkü neden? Herhangi bir örnek veriyorum, Sakarya'da okuyan bir adam neden ODTÜ'nün kaynaklarını inceleyemesin? Belki ekstra bir şey görecek, ekstra bir şey katacak ya da ben buradan MİT'ninkini görebiliyorum mesela. İnsan önündekini böyle biraz daha onu inceleyebilirse, inceleme fırsatı olursa bence daha da ileriye gidebilir yani. Her konuda insana şans vermek gerekiyor (SMI #19)*
>
> *So the materials must be open. Why? I think it is the necessity of the internet, that was already the main goal of the internet while it was being made. I think this must be done. This way, we can reduce the difference of knowledge levels in a society. Why? Let me give an example, why wouldn't a man studying in*

Sakarya be able to look through the resources of METU? Maybe he will see something extra or he will add something extra or for instance I can see MIT's stuff. If a person can look through things ahead of her,if she can have this opportunity, she can go further I mean. We should give a chance to people in every respect (SMI #19)

Some participants also mentioned the benefits of sharing the resources for both the institution and students. For the first argument, one of the faculty members discussed this issue form his perspective:

Şöyle diyeyim bizim hazırlayacağımız kaynak İngilizce olacak hani Türkçe hazırlıyor olsak belki Türkiye'deki diğer üniversiteler için güzel bir kaynak olabilir, hani İngilizce kaynak hazırlayınca hali hazırda MIT'nin, Harward'ın kaynakları varken bizimkisi belki biraz o açıdan şey olabilir ama onların tabii derslerinin içeriği ve content ve şey itibariyle örtüşmeme durumlarıyla belki bizimki daha yerel, klasik bir şey gibi. Bir yandan da düşünüyorum, sesli düşünüyorum hani onlar varken bizim yapmamız ama biraz daha farklı bir tarz olacak, niye zenginleşmesin yani birisi yaptı diye artık bir daha bir şey yapmayacağız anlamına da gelmiyor sonuçta milyon tane kitap var yani organik kimya kitabı var, bir tane doğru bir kitap, şey bir kitap yok yani, genel herkesin çok güzel dediği bir kitap yok. O yüzden evet tamam olabilir (P #3)

I should say that the source that we will prepare is going to be in English. If we were preparing it in Turkish, it could be a good source for the other universities in Turkey. When we prepare a source in English, ours can be a bit … when there are MIT's, Harvard's sources but our courses may not match theirs in terms of the topics and the content and stuff, so ours can be more local or classical. Also I am thinking, thinking aloud about us doing this when theirs are.. . But ours will be in a bit different style. Why wouldn't it be richer? I mean, just because someone else did it, it doesn't mean that we shouldn't do anything anymore. I mean there are millions of books, there is the organic chemistry book, there isn't one right book, which like, everyone considers good. So it can be a yes (P #3)

As mentioned in the comment above, METU could have a pioneer role for providing essential information for students. In addition, Turkish course resources were not sufficient so that these practices could close the gap in this area.

Therefore, the students and faculty members had high expectations from the university each should preserve the quality and popularity among other universities in the world. For the second argument, resources provided by the institution could be beneficial for both own students and other people in the world. Most of the participants mentioned that if the faculty members in different departments provided the resources, their first choices would have been these resources. The supporters of this argument had many reasons. While some students wanted to study on their courses after the classroom especially for their exams, some students interpreted the university's resources more official and reliable. One of the students also mentioned the last reason to prefer their own university's resources:

> *Diğer okullardaki anlatımında buradakinin yani orada % 60-70'i aynı olabilir ama mesela bizim burada üzerinde durduğumuz şeylerin orada üzerinde durulmuyor. Diğer üniversitelerinki de çok yansıtmıyor. Sonuçta bu okulda eğitim veren bir hocanın Open Course Ware videosu olsa direkt onu kendi üniversiteminkini kullanırdım. Çünkü benim gerçekte aldığım dersi o anlatıyor yani (SMI #9)*

> *So as to teaching, 60-70 % of what is taught there in other schools may be the same as the one in here but what we emphasize here is not emphasized there. And it doesn't reflect the one of the other universities. I mean if an instructor in this school had an Open Course Ware video, I would use that of my university for sure. Because she is teaching the course that I am taking (SMI #9)*

4.3.4.2 International Reputation

University's leading role on sharing the resources was also required to presenting them internationally. Some participants thought that the institutions should have some practices through the educational developments. Thus, within these practices, the institution could have an international popularity in academy. Some participants pointed their disappointment about the university's academic popularity and activities. One of the students explained his perception as:

> *Ha izledim şey tabletim var tablet orda iTunes University var mesela bizim okulla ilgili hiçbir şey yok nerdeyse ıı hanı o kadar genellikle övünülür ama pek uluslararası anlamda bir şey yok orda (SMI #7)*

> *Oh yes I watched it, I have a tablet, there is iTunes University for example, but there is almost nothing about our school. Err, it is usually praised but there is nothing international on there (SMI #7)*

Regarding the popularity, one of the teaching assistants highlighted the possible thread for quality of the institution in her comment:

> *Sonuçta biz Türkiye'nin en iyi üniversitelerinden bir tanesiyiz. Bir başkasının ODTÜ'nün sitesine girdiğinde böyle bir şey varmış, ben bakayım dediğimde o dersi bulamaması bence çok kötü bir şey bizim adımıza, yani üniversite adına çok kötü bir şey (TA #3)*
>
> *We are one of the best universities in Turkey after all. I mean, when somebody enters the website of METU and says "Oh there is something like this, I should check it out", and when they cannot find that course, it is really a bad thing for us, I mean, for the university it is a very bad thing (TA #3)*

These participants had an expectation that the university should be the leader for some academic practices. They thought that the university should be located in international academic marketing area and the resources should be provided outside of the university. A student provided a suggestion about this issue in his comment below:

> *Üniversite ne yapsın? Şu an düşünüyorum da onunla ilgili bir sürü şeyler yapılıyor KKM'de, oturumlardı, sempozyumlardı, şunlardı bunlardı. Bunun tanıtımı için böyle bir şey yapılabilir. Çevre üniversitelerden insanlar çağrılabilir. Uluslararası özellikle bir şey yapılabilir ama, bu yapılmadan önce bence bu OCW'nin bir gözden geçirilip geliştirilmesi gerekiyor. Geliştirildikten sonra reklamı da böyle bir şey yapılabilir kesinlikle. Sadece ülke içinde kalmayıp yurt dışı…(SME #10)*
>
> *What can the university do? I am thinking now, there are many things being done about that in KKM, sessions, symposiums and so on. Such a thing can be done as an introduction of this. They can invite other people from nearby universities. Something international can be done but before that, OCW should be revised and developed. After developing it, they can advertise such a thing for sure. Not only in the country, also international stuff (SME #10)*

Another suggestion was to provide the resources through some popular platforms in order to increase the awareness of the resources:

> *Onu mesela hanı iTunes iyi olmasa da ne bilim ODTÜ nün bu şekilde kaynaklarına erişebileceğimiz bir uygulama da olabilir bu hatta uygulama olursa sadece app store da değil mesela Google play store a falan da yayılabilir bu (SME #9)*

Maybe iTunes is not good but I don't know, there can be an application by which we can reach the sources of METU this way. If they make an application out of this, it can be not only on app store but also it can spread on google play store or something (SME #9)

4.3.4.3 Broaden the OERs for Different Courses

In line with the arguments above, most of the participants claimed to have more resources for different courses. The courses they mentioned were diverse but the popular ones were calculus, physics and the laboratory courses based on their profession. One of the students explained this issue from his perspective and desire:

Fizik, kimya, matematik bunlar anlaşılması açıkçası zor dersler. Biyoloji de olabilir, benim bölümümde şu an yok ama farklı kaynaklardan dinlemek, onu çalışmak insana değişik bilgiler katabilir diye düşünüyorum (SMI #15)

Courses such as physics, chemistry, mathematics are actually hard to understand. Also maybe biology, now I don't have it in my department but listening and studying from different source can give different knowledge to people I think (SMI #15)

However, some participants had some concerns about the excessive number of resources so that one of them suggested assigning some faculty members to create their own resources:

Her dersin videosunu koymak abartı olur. Ama mesela 1 kişiyi görevlendirip sen dersi çek ki bunu da hani başkalarına karşı değil, kameraya karşı ve belki birkaç öğrenciye karşı ki hani yanlış yaptığında öğrenciler de yardımcı olabilsin. O tür şeyler güzel olur bence o konuda (SME #16)

Uploading the video of every course would be too much. But for example assigning one person to take the video of the course on the camera, not to the other people but in front of the camera and maybe with a few students, so that they can help when the teacher makes a mistake, such things would be a good idea in this respect (SME #16)

Students also suggested selecting popular faculty members among students to provide their courses in website. Therefore, this strategy could be helpful for some faculty members who was mentioned to have some concerns to openly share their resources. In addition to share different resources, chemistry laboratory resources could also be improved for other students in different universities. The resources was shared openly under the creative commons license, the scope of the content did not beneficial for the students in different departments. A teaching assistant clarified this issue as:

> *Açıkçası evet yani şu an sonuçta o, siz sorduğunuz için tekrar düşündüm sanki şey gibi hani o deneyi yapacak öğrenciler ve o deneye girecek asistanlar kullanabilir gibi. Hâlbuki o aslında kimyanın sayfasında. İsteyen herkes ona ulaşabilir. Ama bu demek oluyor ki çok evet üstünde durulmuyor yani sadece o laba girmeye yönelik. Yani o lablara yönelik bir çalışmaymış gibi kalıyor sanırım. Ama zaten o lablara yönelik amaçla da yapılmış olması yani şu an onu normal bir kimya öğrencisinin izlemesi ona ne katar emin değilim (TA #2)*
>
> *Actually, yes I mean now I think about this again because you've asked, the students who are going to do this experiment and the assistants who are going to be at that experiment can use it. However it is actually on the chemistry page. Everyone who wants can reach it. But that means yes it is not given attention, I mean it's only for entering that lab. I mean it looks like it's a study made for the labs, I guess. But even if it's for those labs, I'm not sure how it would contribute to a normal chemistry student at the moment (TA #2)*

Therefore, while sharing the resources with the world, the content should give a meaning for different people outside of the institution.

4.4 Performance-Outcomes Theme

In this part, the performance outcomes of the students and the OERs' effects on this performance were provided related with the second main research question of this study. First of all the effects of the OERs on students' performances were provided based on the questionnaire responses. Among 117 users, the students' mentioned some effects, which were provided in Table 4.7 below.

Table 4.7 Effects of the OERs on students' performance

Benefit	*f*	%
Yes	99	90
No	11	10
Performance effect	***f***	**%**
Help me to conduct the lab experiment efficiently	61	59.2
Shorten the time to share for the experiments	64	62.1
Help me to understand the experiments	73	70.8
Help me to ask less questions to TAs	47	45.6
Help me to increase my lab grade	34	33.1
Other		

Regarding the users' perspectives for the benefits of the OERs, 90% of the users found them as beneficial. For the benefits of the OERs, the prominent perceived effects were mentioned to help to understand the experiment (70.8%), to shorten the time for experiments (62.1%) and to help to conduct the experiments efficiently (59.2%). As seen from the results, the prominent factors was related with the cognitive and psychomotor domains whereas the OERs were seem to have a less effect on academic outcomes than other domains.

In order to explain the OERs' effects on perceived performance, the qualitative data would provide more detailed information. Therefore, in the following sections, the effects of OERs on students' perceived performances were provided based on qualitative data in this study. This part began with the students' expectation about the course and was followed by the outcomes of using OERs in terms of affective, cognitive, psychomotor skills and academic outcomes. Within the four outcomes, how the students' expectations were met were also provided at the last part of this section.

4.4.1 Expectations about the Course (Input)

The students were asked about the expectations for the laboratory course at the beginning of the semester. Different expectations derived from the interviews and the results were categorized under three domains; cognitive (to have a knowledge about the experiments), psychomotor (to have practical skills) and affective (to get higher grades, satisfaction and enjoyment). The first expectation from the course and the resources was related with the affective domain, which focuses on getting higher grades (N=12). Some students wanted to have satisfactory grades to pass the course. One of the students explained his expectation from the course and the effect of the resources on his comment:

> *Mesela şöyle bakıyoruz, öğrenci olarak açıkçası biraz da quiz ya da not performansı olarak bakıyoruz derslere, bundan dolayı karşılamadı diyorum. Başka türlü bir şey değil (SMI #15)*
>
> *For example we look at it like this, as students we see these courses as a quiz or grade performance, so it hasn't met our expectations. Nothing else (SMI #15)*

Moreover, some students sought for enjoyement through experimental procedure (N=2). For the second domain, psychomotor, while finishing the experiment triggered some students as soon as possible (N=5), some of them expected to have some practical skills about the experiments (N=6). This application also triggered some students' satisfaction for the course. A student expressed his expectation as the quotation below:

> *Not haricinde yanlış anlaşılmasın da ben vakit geçirmeye geliyorum hocam ya. El becerisiydi hani bir kafa dağıtma olarak geliyorum ben aslında. Not için hiç gelmiyorum. Fizik labı da aynı şekilde (SME #13)*
>
> *Except for the grades, don't misunderstand me but I am coming just to spend time, I actually come just for a manual skill or just to busy myself with stuff. I don't attend for the grades. Same for the physics lab (SME #13)*

The third expectation was related with cognitive domain, which was about to have knowledge about the procedure. For some students, the implementation process of the experiments including the steps and the results of the experiments were important (N=6). One of the students stated her expectation as follows:

> *Ben açıkçası biraz İngilizce olduğu için dersler hem İngilizcesini öğrenmek istiyorum, hem de birazcık nerede neyi kullanacağımızı, ne olacağını o tepkime sonucunda onu öğrenmek istiyorum (SME #11)*

> *I actually come because the lessons are in English, I want to learn both the English version and what to use where, what will happen at the end of that reaction (SME #11)*

In addition to that, some students required having some information to interpret the content knowledge in the experiments (N=2). One of the students explained her expectation through this perception:

> *Ya biraz daha şey bekliyordum aslında hani böyle deney yaparken bu deney bunun için yapılıyor. Biz şurada şu hatayı yapıyoruz ama, şöyle durumlar var, şunu şunu hani daha deneyi yapıp geçmek değil de, deneyi neden yapıyoruz, biraz daha mantığının anlatılmasını bekliyorum. Hani tamam deneyin adı belki biraz bilgi veriyor ama hani daha açıklayıcı daha akılda kalıcı şekilde bilgi verilmesini bekliyordum (SMI #11)*

> *Actually I was expecting something else, for example, when the experiment is being done, it is done for this. We are doing that mistake but there are these situations as well, not just" do the experiment and you're done" but, why we are doing that experiment, or I expect them to explain why we are doing that experiment. Okay, maybe the name of this experiment gives it away a bit but I was expecting to get a more explanatory and catchy information (SMI #11)*

The expectations of the teaching assistants and faculty members also indicated the different views among students and them. Faculty members' expectation was mainly comprised by cognitive domain. A faculty member clarified their purpose and expectation for the course as below:

> *Öğrenciden şeyi bekliyoruz, hani yaptığı işi yorumlama, bulduğu sonucu yorumlama yani ben bir sayı buldum, ne bileyim sıcaklık ölçüyorum, dereceden okuyorum yüz derecenin üstünde atıyorum yüz yirmi derecede ama suyun sıcaklığını ölçüyor, bunu yargılayabilmesi lazım gibi yani ve bunlar aslında basit deneyler, akıl yürüterek de çoğuna şey yapabileceği deneyler, dolayısıyla biz onu bekliyoruz ondan ama bunun için de ön hazırlık yapması lazım, yapmadığı için de şu anda sizin dediğiniz oluyor, geliyor laba işte robot gibi okuyor yapıyor, çoğu için konuşalım yani bir kısmı gerçekten yapıyor yani onlara bir şey diyeceğim yok, okuyor yapıyor, okuyor yapıyor ya da gidiyor asistana soruyor çünkü içine hiç ne seyretmiştir, ne föyü okumuştur, biz video koysak da o seyretmeyecek gibi bir şey:) Yani daha iyi video koysak da gene seyretmeyecek (P #2)*

> *We expect the student to be able to interpret the work she is doing interpret the result she finds, I mean "I've found a number"or "I am measuring the*

temperature, I read the temperature as above 100° or 120º…" *but the student should be able to interpret this information and she could do this with simpler experiments or by means of deduction in experiments, so we expect her to do it but she needs to do a preparation for it. Since she doesn't do that, it happens exactly the way you are talking about now. She just comes to the lab and reads and does it like a robot. To speak for most of them, a number of students really do this, I can't say anything about them, they read it, they do it, or they go to the assistants and ask them questions… Some students neither watch anything nor read the leaves, it is something like, if we upload the video, she will not watch it ☺I mean even if we upload the videos, she will not watch them (P #2)*

Regarding the purposes, nearly half of the students did not have any expectation from the course; they just wanted to do the experiment regardless of any particular aims (N=10). Thus, the expectations about the course may vary across students but these results were important to interpret the outcomes of students. In the next four sections, how the resources affected the outcomes were analyzed.

4.4.2 Academic Performance Outcomes

The students' grades were collected and analyzed based on the comparison between the users and non-users' grades by Mann-Whitney test. The results of this test were run for eight conditions, which the number of users and non-users had highest frequency in two semesters. For the first semester, four conditions were analyzed (Exp 2, Exp 3 and Exp 4 for METE group who were informed regularly, and Exp 4 for MINE group who were informed before 4th experiment). For the second semester, similarly four conditions were analyzed but the groups were interchanged based on the informed and non-informed groups (Exp 2, Exp 3 and Exp 4 for MINE group who were informed regularly, and Exp 4 for METE group who were informed before 4th experiment). Based on Mann-Whitney test results, only in two conditions, the grades were significantly differed. For the first semester,

- *Exp 2 in the first semester in METE group*, grades of the students who used OERs (*Mdn*=7.38) did not significantly differed from the students' grades who did not (*Mdn*= 7.13), U=231, z = - .73.

- *Exp 3 in the first semester in METE group*, grades of the students who used OERs (*Mdn*=7.75) did not significantly differed from the students' grades who did not (*Mdn*= 7.88), *U*=222, *z* = - .73
- *Exp 4 in the first semester MINE group*, grades of the students who used OERs (*Mdn*=8.00) did not significantly differed from the students' grades who did not (*Mdn*= 8.63), *U*=233.5, *z* = -1.41
- *Exp 4 in the first semester in METE group*, grades of the students who used OERs (*Mdn*=8.00) did not significantly differed from the students' grades who did not (*Mdn*= 7.50), *U*=168, *z* = -1.65

Regarding the second semester results;

- *Exp 2 in the second semester in MINE group*, grades of the students who used OERs (*Mdn*=8.50) was significantly differed from the students' grades who did not (*Mdn*= 7.50), *U*=326, *z* = -2.32 that the users had higher grades than non-users.
- *Exp 3 in the second semester in MINE group*, grades of the students who used OERs (*Mdn*=6.50) did not significantly differed from the students' grades who did not (*Mdn*= 5.50), *U*=332, *z* = -1.70
- *Exp 4 in the second semester in MINE group*, grades of the students who used OERs (*Mdn*=9.00) was significantly differed from the students' grades who did not (*Mdn*= 8.00), *U*=333.5, *z* = -2.37 that the users had higher grades than non-users.
- *Exp 4 in the second semester in METE group*, grades of the students who used OERs (*Mdn*=7.00) did not significantly differed from the students' grades who did not (*Mdn*= 6.25), *U*=138.5, *z* = -1.53.

Similar with this result, the qualitative data displayed the students' perceived academic outcomes, which more than half of the participants conceived the OERs had not a sufficient effect on their grades (N=21). In GCLC environment, quizzes and reports constituted the main part of the grades. However, it is important to note here that the content of the resources did not refer to the questions asked in the quizzes or reports (N=16). One of the students stated this issue in his quote:

> *Raporu diyorsanız bence etkisi olmaz çünkü rapor ortak yazılan bir şey hanı genelde sıkıntısı olmaz onun giriş quizine de etkisi olmaz hocam giriş quizi çünkü şey yanı orda genelde hanı kitaptaki şeyler sonuçta prosedürü falan okumazsanız sadece o lab aşamasını anlatıyor abc prosedürünü anlatıyor giriş quizine de etkisi olmayacağı için lab puanına bence bir katkısı olmaz rapordan yanı nadir adam vardır öyle düşük alan o da ismi yazmamıştır işte tam anlamamıştır soruyu gene yanı İngilizceden kaynaklı problem var bence (SMI #4)*

> *If you are talking about the report, I think it wouldn't affect anything because a report is written as a group and there won't be any problems. It would not affect the entrance exam?, because the entrance quiz is like, it's usually the things in the book so if you don't read the procedure and such, it only talks about that lab stage, abc procedure. Because it wouldn't affect the entrance exam, it wouldn't contribute to the lab grade. I mean there are very few men who gets a low grade at the reports, I mean he did not write the name or he didn't understand the question, again there is a problem about English (SMI #4)*

Related with this comment, questions in the quizzes were mainly created by the theoretical knowledge and safety instructions in the laboratory book. Four questions were asked in the quizzes and generally two questions from theoretical knowledge, one question from the procedure and one question from the safety instructions formed the structure of the quizzes. Thus, the process-focused instruction did not provide sufficient answers for the questions in the quizzes. A student mentioned this issue form her experience:

> *Quizler biraz daha kitap odaklı ya mesela daha spesifik sorulara yonelık mesela işte bir formülü yazmaya yönelik ya da keyword lere yönelik hanı videoda genel bir anlatım ama quizlerde daha keyword odaklı sorular var o yüzden quizlere mesela videoya çalışıp videoyu işte izleyip ı lab kitabını okumadan geldiğim quizlerde yapamadığım sorular oldu (SME #9)*

> *Quizzes are mostly based on books, for example they focus on more specific questions for instance about writing a formula or about keyword. There is a more overall explanation in videos but the quiz questions are based on keywords more. That's why for example, since I entered the quizzes just after*

studying and watching the video, without reading the lab books, I couldn't answer some of the questions (SME #9)

Some students and teaching assistants mentioned that the OERs could have an indirect effect on their grades. They argued that the resources helped to understand and to implement the process, which could affect the score they have (N=11). If the student knew the procedure, they could focus on the theory in the teaching process. Thus, this indirect effect recognized while writing the reports as one of the research assistants remarked:

Lab notları biraz rapor yazma ile alakalı olduğu için hani burada şeye dönebiliriz belki direkt etkisi olmaz ama in direkt olarak teoriye daha çok odaklanacakları için biraz önce konuştuk ya hani deneyi daha iyi anlarlar. Rapor yazarken daha başarılı olabilirler (TA #1)

Since lab grades are about writing reports, we can talk about, maybe it wouldn't affect directly but indirectly, because the students would concentrate more on theory, just like we talked a bit ago, they would understand the experiment better. They would be able to be more successful in writing the report (TA #1)

On the contrary, with the comments above, some participants mentioned that the resources made them to get higher grades in the course (N=15). Resources helped the participants to study on the course, which positively affects their grades.

Hatta bu sene bu lab dersleri benim sınav notlarımın da yükselmesini sağladı çünkü hanı o konuyu derse gitmeden öğrenmiş oluyorum işte asit baz olsun işte diğer denge konuları olsun hanı işlem de yaptığım için bir yandan çok faydalı oldu lab notlarıma video izlemek yanı konuyu bilerek gelmek (SME #9)

For that matter, these lab courses have helped my exam grades rise this year since I learn about that topic before I enter the course like, acids or base or other balance topics? Because I do processing, entering courses after watching the videos and knowing the subject have been very beneficial on my lab grades (SME #9)

However, it was not so possible to measure the direct effect of the OERs on the performance because there could be many factors, which were connected with the grades. A student explained one of them:

Notumu etkilememiş olabilir. Çünkü bir şekilde birbirimize bakarak yapıyorduk zaten deneyleri (SME #11)

Maybe it hasn't affected my grades because we were doing the experiments by watching what each other was doing (SME #11)

4.4.2.1 Comparison of Group Performances

Derived from the observations, two groups were not dramatically different from each other upon the laboratory performances. The teaching assistants were asked for their observations about the group performances. Some of them (N=6) declared that there was no difference between them:

Metalürjide öğrenciler daha şey daha doğrusu ikisi de kimyaya göre kıyaslarsak çok ilgilenmiyorlar. Neden bu dersi alıyoruz diye düşünen çok öğrenci var. Hani çok bir şey diyemeyeceğim bu konuda. Yani çok da bir farkları yok (TA #5)

In metallurgy department, students are more, um, more honestly both of them aren't really interested when compared to chemistry department. There are so many students who think about why they are taking that course. So I can't say much about this. I mean they are not very different (TA #5)

On the other hand, some assistants (N=5) defined METE group to have a higher performance in the course environment.

Katılıyorum var. Ben geçen dönemde giriyordum zaten 2 gruba da yani bence var. Metalürji daha kolay anlıyor diyebilirim ve deney performansları da bence madene göre daha iyi oldu (TA #7)

I agree that there are. I was teaching both of the groups last semester I mean there are. I can say that metallurgy students understand better and their lab performance has got better when compared to mining department (TA #7)

Regarding other groups except METE and MINE, some teaching assistants noticed the different performances between the departments. Many factors were mentioned which possibly created the performance differences in terms of the interest for the course, the educational background, success on the university exam (OSS) and the personal differences. Some teaching assistants and faculty member interpreted this issue regarding the exam scores for university entrance. They claimed that students with higher grades were more successful in this course. A quote from the faculty member clarified this issue as:

> *Çok fark var, yani üniversite giriş sınavıyla dersteki ilgi ve başarı neredeyse birebir. Ne kadar biz onları birazcık derste şey yapsak bile yine de sıralamada birazcık yaklaşıyordur, büyük bir fark yaratan görmedim, 7 kaç yıl olmuştu, 7 yıldır buradayım ve çok bölüme ders verdim hemen hemen hepsine ders verdim yani o üniversite giriş sınavıyla dersteki ilgi ve başarıları gidiyor. Avarage'da konuşuyoruz tabii yoksa her sınıfın çok iyi çocukları var (P #2)*

> *There are so many differences; I mean the enthusiasm and success they perform in their lessons fade away with the university entrance exam. No matter how much we … them in the courses, they get closer in the ranking, I haven't seen anyone who has made a big difference. 7, how many years has it been, I have been here for 7 years and I have taught in many departments, almost all of them, I mean the interest and success fades away with that university entrance exam. Of course we are talking on average, otherwise there are very good students in every class (P #2)*

In addition to this issue, one of the research assistants also clarified the difference between the departments by studying responsibility.

> *Geçen dönem ben çevre mühendisliğindeydim, onlar gerçekten iyilerdi. Ben kimya mühendisliğine hiç girmedim ama işte giren arkadaşlarımız çok çok iyi olduklarını söylüyorlar. İnşaatçılar iyiler, en azından şöyle söyleyim notları güzel. Eğer ilgisizlerse de ama mecburiyet bile olsa yapıyorlar. Üstlerine düşen vazifeyi yapıyorlar (TA #3)*

> *Last year I was teaching in the department of environmental engineering they were really good. I have never taught in the chemistry engineering but our friends who have say that they are very good. The students in civil engineering are good; I should say at least their grades are high. Even if they are not interested or they are obliged to do it, they do it. They do what they need to do (TA #3)*

Some of the assistants defined the interest for the course as a major indicator for the performance. The students from the departments, which offered chemistry related courses, were more eager to do the experiments in the course environment. The dialogue between the researcher and the teaching assistant clarified this issue:

> Interviewee: *Aslında genelde performansı şu etkiliyor bence mühendislik öğrencilerinin çok büyük bir ilgisi yok ama kimya ile daha iç içe olan gruplar*

daha ilgili oldukları için biraz daha rahat daha iyi anlama niyetli oldukları için daha iyi diye düşünüyorum ama en üst notu kime veriyoruz biz? Bilgisayarcılarda geliyor, onlar ile işte kimya mühendisleri aynı olmuyor öyle diyim.

Interviewer: *Peki, sizde kimyaya daha hevesli olan gruplar hangisi? Yani kimya mühendisliği var zaten. Onun haricinde böyle mühendislik gruplarından?*

Interviewee: *Genetik grupları. Genetiğe gerçi ben girmedim bu servis kimyasında veriliyor yani hangi tarafta verildiğini bilmiyorum ama onlarda daha şey diye hatırlıyorum. Bu yıl girmedim de. Kimya mühendisleri, biyolojiciler. Zaten mühendislik öğrencilerinden şunu çok duyuyoruz hani şey anlamasam ne olacak ki nerede kullanacağım bunu. O şekilde yaklaşıyorlar (TA #6)*

Interviewee: *Actually, I think what affects the performance is that engineering students are not very interested but because the groups who are more involved with chemistry are more interested and because they intend to understand the courses more, that's why they are better. However, who are we giving the highest grade? Let me tell you that, computer engineering students are coming, they and chemistry students are not the same*

Interviewer: *So, which of your groups are more enthusiastic about chemistry? I mean, there is chemistry engineering already. Who, except for them?*

Interviewee: *Genetics groups. I haven't taught in genetics though, this is taught in service chemistry, I mean I don't know which area it is taught but I remember that they were more enthusiastic. I haven't taught there this year. Chemistry engineering students, biologists. We already here a lot from the engineering students that: "So what, if I don't understand this? Where will I use this?" This is how they approach it (TA #6)*

As seen in the differences above, the interest for the course generally created one of the major indicator for the academic performance. In addition, the groups with higher university exam grades were defined to generally have the studying responsibility so that they had more comfortable course environment than other groups.

4.4.3 Cognitive Outcomes

Based on taxonomy of educational objectives (Bloom et. al., 1956; Krathwohl, 2002), cognitive outcomes divided into two categories, which refer to first two categories in the taxonomy: knowledge and comprehension. Derived from the observations and interviews, the learning activities and the OERs mostly indicated the knowledge category in the taxonomy.

4.4.3.1 Remember/ Knowledge

The OERs perceived effects on students' knowledge were examined under two categories: procedural knowledge and factual-conceptual knowledge.

4.4.3.1.1 Factual-Conceptual Knowledge

For the factual-conceptual knowledge, there were not promising outcomes because the OERs did not provide the content knowledge in its environment. The first benefit of the resource was to provide some visual identification of the chemicals and equipment (N=6) (knowledge of specific details and elements). One of the students mentioned the effect as:

> *Daha fazla malzeme var, kimyasallar var, hani kullandığımız şeyler her hafta farklı olabiliyor, beher gibi aparatlar dışında. Derece kullanıyoruz, bir hafta iste isi yalıtımı kap kullanıyoruz. O yüzden her şeyi tanımamız için gerekli olduğunu düşünüyorum (SMI #15)*
>
> *There are more kits, chemicals, I mean the things we use, they can be different every week, except for the beaker kit. We use scale or we use heat insulated vessels, so I think it is necessary to know everything (SMI #15)*

In line with this issue, the OERs also assisted the students to be familiar with the characteristics of the chemicals.(N=4) A teaching assistant shared her experience as below:

> *Bence faydalı çünkü öğrenciler hangi kimyasalın sıvı mi kati mi yani ne olduğunu bilmiyorlar. Solüsyon olduğunu da bilmiyorlar. Zaten bunları öğrenmek için geliyorlar. Hani onları o şekilde gördüklerinde tanımış oluyorlar. Ha bu budur deyip oraya doğru yönelebiliyorlar (TA #5)*
>
> *I think it is beneficial because students don't know which chemical is liquid or solid, what they are or that it is a solution. They already come to learn about these. When they see them like that, they recognize them. They say "Oh, this is it" and they head towards that area (TA #5)*

On the other hand, one of the teaching assistants argued that the resources did not provide sufficient information about the chemicals:

> *Şimdi mesela voltaic cell, entalpi deneylerini izledim, bunlar hakkında notlar aldım. En başında şeyle başlıyor, kimyasallar, deneyde kullanılacak kimyasallar ve aparatlar. Ondan sonra prosedürde sıra sıra anlatılıyor işte ne yapılacak, nasıl eklenecek falan. Fakat kimyasalları hiç tanıtmıyor, hani şu şudur, bu asittir, bu bazdır, böyle kullanırsak şu zararı olur, işte solumayalım, tenimize temas etmesin gibi hiçbir şey yok (TA #4)*

> *I've watched voltaic cell and enthalpy experiments, I've taken notes about them. In the beginning it starts with chemicals, the chemicals that will be used in the experiment and kits. After that, they start telling about the procedure respectively, what will be done, how it will be added etc. But it never introduces chemicals like "This is that,? This is an acid, that's a base, if we use it like this, it will do harm like that, we shouldn't inhale it, we shouldn't touch it etc.; there is nothing like that (TA #4)*

Some research assistants highlighted the possible indirect effect of the OERs on content knowledge as to help to prepare their mind to learn the content knowledge (knowledge of principles, theories and generalization). They proposed that the initial learning of the procedure of the experiment could help the students to focus on the conceptual knowledge and interpretation part which enable them to prepare their mind (N=6). One of the assistants specified this issue as:

> *Yani ne yapacaklarını anladıkları zaman bir adim öne geçmiş oluyorlar. Ne için yapıyorlar artık o aşamayı geçmiş oluyorlar. Çünkü hiç bilmeden gelince, gözlerinde canlandıramayınca, ne yapacağız simdi neyi neye katacağız ona odaklanıyorlar. Olayı anlama kısmında olmuyorlar hani amaç olmuyor o esnada. Önceden bunu görürlerse (materyallerden bahsediyor) en azından diyorum ki mesela büret alacaksınız. Büret hangisi diyor mesela. Orada onun ne olduğunu bilecek yani hem kendi daha iyi hızlı ilerleyecek hem de anlayarak gidecek. Sen anlattığın zaman üzerine pekişmiş olacak. En azından hesap yani simdi şey oluyor, ne yapacağımıza odaklanıyorlar. O aşamayı geçmiş olacak (TA #6)*

> *I mean when they understand what they are going to to, they go one step further. They have passed the stage of "why they are doing this". Because when they come without knowing anything, when they can't visualize anything, they focus on what they are going to add to what. They are not at the understanding part, it's not the goal at that point If they have seen that from*

the beginning (she's/he's talking about the materials), at least I say "You will get burets". She says "Which one is buret?"If she knows what that is, she will improve faster and she will continue with an understanding. When you tell abou it, her knowledge will be reinforced. At least the calculation is like, they concentrate on what we will do. She will have passed that stage (TA #6)

However, related with the content knowledge, the OERs did not promise higher expectations and consequences. The scope of the content in the resources mainly focused on the procedure of the experiments so that the system tries to offer this type of knowledge through the laboratory book and the teaching process in the course environment.

4.4.3.1.2 Procedural Knowledge

For the procedural knowledge, the OERs had an effect on memorization in order to implement the procedure of the experiment. The first benefit mentioned was to help the students to understand the procedure at least (N_s=17, N_{ta}=6). One of the students expressed his experience as:

Lab sırasında ne yaptığını tam anlamıyorsun hani mesela bir şeyi bir şeye katıyorsun ama onlar ne bilmiyorsun çünkü orada bir not almaya çalıştığın için, iste bu kaynakları kullanınca biraz hani ne olduğunu hani yazılı olarak iste özellikle simülasyonda ne olduğunu anlayınca olayı hani anlıyorsun (SME #4)

You don't understand what you are doing during the lab, I mean for example you mix something in something but you don't know what they are because, since you are trying to get a grade there, when you use those resources, you get to understand what they are when you see what happens in the simulation particularly (SME #4)

In addition to that, the resources helped some students to remember the procedure of the experiments (N_s=19, N_{ta}=3). A student expressed the outcome from his experience:

Ben sadece orada dinleyip ve her yarım saatte bir sürekli ne yapacağımı sorup deneyi bitirdiğim zaman bir şey anlamıyorum. Buraya gelip oturuyoruz arkadaşlar işlemler nasıl yapılıyor deyip teslim ediyorum. Yani deneye dair aklımda hiç bir şey kalmıyor ama öncesinde izlediğim sonrasında kendim uyguladığım deney olduğu zaman daha akılda kalıcı oluyor (SMI #8)

When I go to the lab and just listen and ask what I should do every half an hour and finish the experiment, I don't really understand anything. We just come here and I ask how the procedure is done and then I submit it. I mean nothing about the experiment becomes permanent in my memory. But when I watch the videos first, and then I practice that experiment by myself, it becomes more permanent (SMI #8)

Related with the memorization, a teaching assistant shared her memory about the users' recall of experiments.

Laboratuvarda herkes izleyerek gelmiyor, bizim deneyimlediğimiz kadarıyla ama izleyenler de direk kıyas yoluna gidiyorlar. Yani aslında faydası oluyor. Videoda şu şekilde yapılıyordu biz de bu şekilde mi yapacağız çünkü zaten 2010 da çekilmiş videolar. Dolayısıyla onu kıyaslamış yani. 2014 yılında hala ayni şekilde mi yapıyoruz diye sordu. Bu şekilde mi yapacağız vesaire aklında kalmış, faydası olmuş demek ki (TA #11)

Not everyone in the lab watches the videos, as far as we have experienced so far, but the ones who have watched them start comparing them. I mean it actually helps. Like "it was done like this in the video, should we do it that way too" because the videos were filmed in 2010. So the student compares them. She asked if we were doing it the same way in 2014. "Are we going to do it that way?" etc., so she remembered it, it helped (TA #11)

The OERs helped participants to visualize the process better than the laboratory book, which supports the findings about the quality of the content knowledge in laboratory book (N=11).

Çünkü kitapta okuyunca hani gözümde hiç bir şey canlanmadı ne yapıp ne yapmayacağıma dair. Kaynaklar bayağı yardımcı oldu ne yapıp yapmayacağıma (SMI #12)

Because when I was reading it in the book, I couldn't visualize anything about what I should and shouldn't do. Those resources helped me a lot about what I should and shouldn't do (SMI #12)

Similar with the students, the OERs also have an effect on teaching assistants' memorization and visualization of the experimentation process (N=5).

Videolar özellikle yeni başlayan bir asistan için yeri geldiğinde çok hayat kurtarıcı oldu. Çünkü dediğim gibi daha önce yaptırmadık, daha önce bir tecrübemiz olmadı. Önümüzdeki donem ben tabi çok daha rahat olacağım. Çünkü bir donem çocuklara o deneyleri yaptırmış olacağım. Mesela su *anda videoları düşünüyorum önümüzdeki donem ben tekrar devam edeceğim, öyle olduğunda ben tekrar izlemem diyemiyorum çünkü unutuyor olacağım (TA #8)*

Videos have been life-saving for a newly-recruited assistant at times because as I said before, we hadn't had that done before, we hadn't had an experience. Next semester I will be more comfortable of course since I will have had the students do those experiments. For example now I am thinking about those experiments, I will continue next semester, and when that happens, I won't say I won't watch them again because I will be forgetting them (TA #8)

Correspondingly, visualizing the process also helped novice learners how to apply the procedure in practice (N=5). A student explained his concern and the effects of the resources on that in the following quote:

Mesela bazı insanlar var daha önce de lab deneyimi olan insanlar ama benim yok hani benim gibi çoğu insan da var hani bizim için yapacağımız şeyi görsel olarak görmek etkili oluyor yani orada ne kadar asistanlar tahtada da anlatsa bazen eyleme geldiğimiz zaman isteneni yapamayabiliyorum (SMI #7)

May it be physics or chemistry, a person stumbles when she sees new stuff, I mean how it should be written and how it should be done is written on that procedure but we think about how we are going to do it since we haven't done much practice (SMI #7)

One of the faculty members also provided his comments about the possible effects of the OERs on students' procedural knowledge. He claimed that the resources could support students' practical applications during the procedure:

Genelde laboratuvarda bilmiyorum siz laboratuvar dersini hatırlar misiniz aldığınız şeyleri hani böyle kağıt üzerindeki prosedürü o an böyle fiiliyata geçirmek ilk şeyde insan çok tutuk oluyor. Ama daha önce onu birisi yaparken izlediğiniz zaman hakikaten mesela beheri aldı, çözelti hazırladı, onu ona doktu filan hani kafada ne yapacağınız çok daha netleşiyor. Özellikle deney üzerinde o videoların çok etkili olduğunu düşünüyorum (P #3)

Generally in the labs, I don't know if you could remember lab courses and what you took, I mean a person can be very timid while putting the procedure on the paper into action. But when you watch it beforehand, like when somebody is taking the beaker, preparing the solution, pouring it into that etc. it becomes really more clear in your mind what you are going to *do. I think those videos are very influential on the experiments especially (P #3)*

However, for the procedural knowledge, most positive outcomes were defined with using videos rather than simulations. Most participants mentioned that the simulation environment were not successful to provide procedural knowledge as provided in videos. One of the teaching assistants clarifies this issue as below:

> *Deneyin mantığını anlama konusunda simülasyonların çok etkili olduğunu düşünmüyorum. Çünkü simülasyonda zaten orada bir beher görüyor ve işte bir büret görüyorsa onu onun içine koyup dökeceği belli. Yani hani bu böyle yapılır diye yapılacağı şeyleri yani deneyde yapması gereken şeyleri çok etkili bir biçimde anlattığını, çocuğa öğrettiğini düşünmüyorum ama evet çok eğlenceli ve hiçbir sakıncası olduğunu düşünmüyorum (TA #8)*
>
> *I think simulations are very effective for understand the reason behind an experiment. Because it is already very obvious in the videos that he sees a beaker and if he sees a buret, he will put it in there and pour it down. I mean I don't think he is telling what to do like "This is how it is done" very effectively and teaches it to children that way. But it is very much fun and I don't think they are harmful in any ways (TA #8)*

4.4.3.2 Understand/Comprehension

This part aimed to provide some results about the comprehension. Most of the participants described their experiences as with the words of *memorization*, *remember* and *understanding*, only small part of participants referred to the words of *comprehension* and *interpretation*. (N=4) One of the statements about the comprehension was to implement the process consciously:

> *Bir kere hani daha bilinçli geldiğimiz için daha kolay yapabiliyoruz, yaptığımız şeyleri daha iyi anlayabiliyoruz (SME #9)*
>
> *For one thing, because we come to there with more knowledge, we can do it more easily and we can understand what we are doing in a better way (SME #9)*

Another statement about the comprehension was to learn the purpose of the experimentation process. One of the students expressed his experience in his quote below:

Yani neyi bulmamız gerektiğini yani o deneyi ne için yaptığımızı öğreniyoruz hani videoyu izleyince onu kavramış oluyorsunuz ve hani geldiğiniz zaman da quizde onunla ilgili bir soru olduğu zaman cevaplayabiliyorsun (SMI #7)

I mean we learn what we are supposed to find and why we are doing that experiment. I mean when you have watched the video that means you have grasped that and when you come there you can answer a question about that in the quiz (SMI #7)

However, the major argument about the OERs was related with the interpretation. This issue also related with what students learnt about the content from the laboratory book and the teaching process. Mentioned in the teaching process part, the processes in the system (teaching and learning) and the OERs did not provide any critical thinking for learners. The cognitive level of the students possibly remained on the knowledge level. Most of the students were criticized to have meaningless learning experiment in the laboratory environment, which was supported by the results in the teaching process. One of the faculty members criticized this issue within the dialogue between the researcher and faculty member:

Interviewee: *Orada öğrenci seyrettiği zaman aslında öğrenci sadece ha bu böyle oluyor, bu böyle oluyor çünkü yani bu o. Yani bilmiyorum yani garip bir şeyi var yani öğrenci bir şeye baktığı zaman kendim de ayniyim, ayni şekilde ha bu böyleymiş yani tamam, gidiyorum ezbere yapıyorum.*

Interviewer: *Ezberlediklerini mi düşünüyorsunuz?*

Interviewee: *Yani ezberleniyor. Ha bazı çocuklar tabi ki kritik düşünceyi vermeyince ezberleniyor ama kritik düşünce verilince bu adam da burada hata yapmış deniliyor. Bak eldiven dahi giymemiş, kimya labı diye kaç tane öğrenci çıktı, hiç öğrenci çıkmadı (P #4)*

Interviewee: *When a student watches it on there, he actually says like, "Oh this is it, this is how it's done because this is it." I mean I don't know because it's something strange, I mean when a student watches something, he goes like "I'm the same, the same way, oh this is like that, okay, I should go and do it by rote*

Interviewer: *Do you think they memorize it?*

Interviewee: *It is memorized. Surely some of the students memorize it when the critical thinking is not taught but when it is taught, they say "This man* *made a mistake on that point." How many students have come out and said "Look, he isn't even wearing gloves"? None (P #4)*

Similar with the faculty members, some students also argued this issue from his experience with the resources as in the quote below:

Simülasyonlar ve video, kitapta ne yapılması gerektiğini soyluyor. Mesela en fazla açıkladığı şey: su maddeyi katıyoruz katalizör olarak. Tamam mesela kattım onu da benim yaptığım işlem ne? Tamam ben ona katalizörü katıyorum ama şey mesela, üzerine ışık düşürdük bir tane deneyde, ben sonradan öğrendim üzerine düşürdüğümüz ışık iste oradan elektronu koparıyormuş, o ona göre renk veriyormuş. Onu ben bitirdikten sonra anladım her şey, yaparken ben neden bunu böyle boyadım, iste neden ışığa tuttum hiçbir şey bilmediğim için tamamen o videoda gördüğüm gibi, kitapta okuduğum gibi ezbere dayalı yaptım yani (SMI #19)

Simulations and the videos are telling what to do in the book. For example what to explain the most is, "We are adding this substance as a catalyzer". Okay let's say that I added it but what is the activity that I am doing? Alright, I am adding the catalyzer into that thing but for example, we exposed it onto the light in an experiment and I learned later that the light we reflected onto it plucked the electron off, and it turns into a color according to that. I understood it after I finished it, I did it by heart just like what I saw in the video, just like the way I read it in the book, I didn't know why it gave off that color and why I held it against the light (SMI #19)

Thus, the teaching and assessment process, which relied on the memorization rather than the interpretation, affected the students' content knowledge in the laboratory course. Neither the resources nor the opportunities which system provided seemed to be successful for satisfactory content knowledge.

One of the faculty members also examined this issue through the educational system. He argued that our educational system supported the students to get higher grades rather than to learn and interpret the knowledge.

Öğreniyorum demiyorlar ve demeyecekler çünkü sistem onu soyluyor sana. Çünkü yarın öbür gün kimse sana senin ne kadar öğrendiğini ne kadar içselleştirdiğini ne kadar oturttuğunu ölçmüyor herkes çünkü hocalarımız dahi zamanında AA getiren hocalarımız değil mi? (P #4)

They are not saying that they are learning it and they won't because the system is saying that to you. Because tomorrow or the day after, nobody will tell you how much you have learned and how much you have interiorized it and how much you have pinned it into your mind because even our teachers, aren't they the ones who got AA back in the time? (P #4)

Related with this criticism, a teaching assistant interpreted the students' learning in this course through this perspective in the following comment:

Mesela prosedürde gerekli adımları teker teker gösteriyor. O adımları takip ederek güzel sonuçlar elde edebilirler. Ama güzel sonuç elde edebiliyor olmaları anladıkları anlamına gelmez bence, yine yalnızca yüksek not almalarını sağlayabilir sadece (TA #4)

For example they show you the necessary steps one by one in the procedure. They can follow those steps and can get good results. But when they get good results, it doesn't mean that they have understood it, it can only help them get high grades (TA #4)

Therefore, the teaching method, assessment techniques and the resources did not support the students' learning process based on comprehension and interpretation. They only helped to finish the experiments successfully.

4.4.4 Psychomotor Skills and Activities

4.4.4.1 Technique in Using Chemicals and Equipment

Some participants mentioned that the OERs had an effect on how to use the chemicals and equipment. Supported by knowing the chemicals and their characteristics in factual-conceptual knowledge part, ability to use them was also provided by the resources (N_s=9, N_{ta}=4). One of the students mentioned the effects as in the quote below:

El becerisi olarak etkisi oluyor, orada nasıl tartılacağı, nasıl hangi sıvıların beherlere konulacağı falan konulacağını gösterdiği için (SME #13)

It helps as a manual skill because they show how it's weighed, which liquids to put in the beakers etc. on there (SME #13)

Related with this issue, some students were observed to have difficulties on setting up the experiments. They mostly received support from other students or teaching assistants. Similar with this observation, one of the research assistants shared her experience about the ability to use chemicals and equipment as:

> *Karıştır dediğimde neyle karıştıracağını bilmiyor. Masayla tutmayı bilmiyor aslında hani videoların o şeyi de güzel. Maşayla nasıl tutarım, şeyi nasıl kurarım düzeneği. Evet, o tip el becerisi tarzı şeyleri geliştirmek için tabii video daha iyi, kitapta gösterilemiyor. Çünkü tek tek her gruba deney kurmak ya da hani bir voltmetreyi nasıl kullanacağını göstermek , ne bileyim büreti nasıl kullanacağını göstermek kalabalık gruplarda çok zor (TA #9)*

> *When I tell them to mix it, the student doesn't know what to mix it with. He doesn't know how to hold it with the tongs, actually this is the good thing about the videos. How I hold it with the tongs, how I place the thing mechanism. Yes, the video is better in order to develop manual skills and that kind of stuff, they are not shown in the book. Because it is too hard in crowded groups to ? help the experiment or show how to use a voltmeter or how to use a buret to every group (TA #9)*

Related with the using techniques, the OERs also had an effect by offering safety instructions and some key knowledge for some parts of the experiments (N=3). One of the students mentioned this issue derived from his experience as:

> *Başarılı mesela şu örneği vereceğim, bir deneyde siyanür kullanmamız gerekiyordu ve çok tehlikeli olduğunu bilsek de orada bizi 2 sefer 3 sefer uyarıyor. Bu yüzden daha dikkatli olmam gerektiğini düşünerek geldim (SME #4)*

> *Successful as in, I will give an example. We were supposed to use cyanide in an experiment and even though we had known how dangerous it was, it warned us 2 or 3 times. So I came to there knowing that I should be more careful (SME #4)*

Learning how to use the chemicals, equipment and technics could be beneficial for students in their future professional life. One of the faculty members pointed the benefit of the resources from this issue as:

> *Mesela internet ortamından dışarıya da açılması iyi olabilir. Çünkü mesela öğrenci staja gidiyor, bir tekniği öğrenmiş olması lazım. Yani acip oradan*

öğrenebilir. Gerçekten iyi hazırlanmış bir materyalse. Bir aletin nasıl kullanıldığını öğrenip gitmek çok avantaj sağlayabilir. Mesela boyle bir eksikliğimiz var, eğitimin parçası olabilir (P #1)

For instance it might be good to spread it on the internet. Because for example, a student does her internship, she should learn a technique, so she can look it up and learn about it on there, if it's a really well-prepared material. It can be very advantageous to learn how a device is used and go to the course after that. We have this deficiency, so it can be a part of the education (P #1)

4.4.4.2 Duration of Experimentation

The second issue related with psychomotor skills was related with the duration of the experimentation. Most of the participants who used the OERs at least one time, mentioned that the resources decreased their time in the experimentation process in the course environment (N_s=26, N_{ta}=5). One of the students referred to this issue as:

Ben deneyi önceden gördüğüm için nasıl yapıldığını biliyorum. Mesela kaçan aşamaları millet gidip, hani arkadaşlar gidip hocaya sürekli sormak zorunda kalıyorlar. Simdi ne yapacağız, neydi diye ama ben zaten biliyorum deneyi, bu konuda hızlandırıyor (SMI #11)

Since I have seen the experiment before, I know how it's done. For example my friends have to go and ask the teacher the stages they have missed. "What will we do now? What was that?" but I already know the experiment so that accelerates it in that way (SMI #11)

Another student criticized this situation from the teaching process in the laboratory environment. Student also emphasized the problem in the teaching process, which was mentioned in the adoption section.

Lab öncesi bize anlatılanlar, labı gerçekleştirmem için çok faydalı olmuyor. Çünkü cümleler ile anlatılanlar deney sırasında kayboluyor. Deneyin prosesi fazla uzun, stepleri atlıyorum ama en azından videoda kafamda ne olacağı hazırdı. Yani o asit baz tepkimesini daha hızlı bitirdiğimi hatırlıyorum (SME #7)

What we are told before the lab hasn't been very beneficial so as to realize the lab. Because what is said within sentences disappears during the experiment. The process of the experiment is too long, I skip some steps but *at least what will happen in the video is all ready in my mind. So I remember completing that acid-base reaction more quickly (SME #7)*

On the contrary, for some students, the use of OERs did not offer shorter experimentation process to complete (N=6). One of the students explained this issue that he did not memorize the procedure properly to finish the experiment earlier.

Yani simdi videoyu izlediğimde, izlediğim gün hani tamamen anlıyorum fakat, ertesi gün biraz daha bilgiler taze kalmadığı için, fazla etkisi olduğunu süre açısından söyleyemeyeceğim (SMI #13)

So when I watch the video, I understand it completely on the day I watch it, but the next day the information doesn't stay as fresh as it was. So I can't say that it is effective much in terms of time (SMI #13)

In addition, the partners' performance differences and personal differences were mentioned to affect the time spent for the experiments. In some groups, the conflict between the group members could increase the experimentation process. Regarding the personal differences, a student explained his behavior as follows:

Ondaki olay şöyle; ben zaten her şeyi yavaş yaptığım için olsa da, olmasa da ben gene hep en son çıkıyorum labdan. En son ben orayı silip, kapatıyorlar ondan sonra laboratuarı. Yani o tamamen benlik bir şey, onunla alakalı bir şey olduğunu zannetmiyorum (SMI #19)

The thing about that is; since I already do everything slowly, whether it is successful or not successful?, I am the last to leave the lab. In the last moments, I clean the lab and then they close it. I mean that's totally about me, I don't think it's about that (SMI #19)

4.4.5 Affective Outcomes

In this part, the participants' attitudes towards the OERs were provided under three parts in terms of quality of the resources, benefits of the resources and the necessity of the resources.

4.4.5.1 Attitudes towards the Course Materials

4.4.5.1.1 Evaluations about the Quality of the Course Materials

During the interviews, participants evaluated the quality of the OERs. This part constituted video, simulation, comparison of laboratory book and resources and the attitudes towards the online and printed materials.

4.4.5.1.1.1 Video

Most of the participants described the video environment as successful in some technical and conceptual details in terms of visual quality and teaching process (N=17). One of the students mentioned her perception about the video as:

> *Ses iyiydi, güzeldi. Video bence kaliteliydi, görüntü kalitesi güzeldi, netti, anlaşılırdı. Konuşmalar da netti ve anlaşılırdı. Baştaki o içindekiler onlar da gayet anlaşılırdı. Yani sevdim (SMI #18)*
>
> *The sound was okay, it was alright. I think the video had a good quality, image quality was good, it was clear. The conversations were more clear and intelligible. The things in the beginning were also very comprehensible. So I liked it (SMI #18)*

Similarly, most of the participants were satisfied with the length of the videos (N=23), with 6-7 min length, videos were expressed as suitable to explain the experiments. One of the teaching assistants mentioned her experience as stated below:

> *Gayet iyi zaten ortalama 6-7-8 dakika gibi sürelerde. Ne çok zaman alabilecek bir süre, ne çok sıkacak kadar uzun bir süre. Yani insan 10 dakikasını ayırıp bu deney neymiş şeklinde öğrenebiliyor yani o konuda hiçbir sıkıntısı yok (TA #2)*
>
> *Very good, they take 6-7-8 minutes on average. It's not a long time, neither it's too time-taking nor it is too long to get you bored. I mean a person can spare 10 minutes of his and learn what this experiment is, so there is no problem with that (TA #2)*

However, some participants stated that they would prefer to watch 3-4 min length videos (N=2). Especially, some teaching assistants described this preference as to know the content knowledge better than the students did. Regarding the teaching process, the participants generally defined the teaching process as simple to understand as a teaching assistant stated below:

> *Deney prosedürünü çok iyi anlattığını söyleyebilirim. Anlatım olarak da ben nice video izledim, yani aksam da çok iyi, çok anlaşılır bir aksam. Olabildiğince basit anlatmışlar, anlaşılır. Yani prosedürü çok güzel bir şekilde anlayabilir bir öğrenci izlediği zaman (TA #4)*

> *I can say that it tells about the experiment procedure very well. When it comes to the manner of telling, I've watched so many videos, so in these, the components are also very good and comprehensible. They told very simply, understandably. I mean a student can understand the procedure very well when she watches it (TA #4)*

4.4.5.1.1.1.1 Criticism about the videos

While some participants were satisfied with the current version of videos (N=12), som of them had some concerns about the quality of videos thus, beside positive features of the videos, many criticisms emerged during the interviews.

4.4.5.1.1.1.1.1 Visual quality

While most of the students were satisfied with the visual quality of the videos, some of them evaluated videos to have poor visual quality (N=8). Some participants explained this with the old-fashioned visual quality as in the quote below:

> *Video ve simülasyonun kalitesi dediğim gibi biraz 2010 senesinde yapılmış gibi, 3-4 sene öncesinde yapılmış gibi. Güncellense kesinlikle çok daha güzel bir şey çıkar yani şu anın teknolojisiyle (SME #19)*

> *The quality of the video and the simulation is like it was made in 2010, as I said before, it's like it was done 3-4 years ago. If it gets updated, with today's technology, something totally better will come out for sure (SME #19)*

4.4.5.1.1.1.1.2 Quality of the teaching process

The third issue was related with the quality of the teaching process in videos. Two main criticisms mentioned by the participants as the unattractive teaching process and unsatisfactory content knowledge. For the first issue, for some participants, video environment did not provide different teaching process than the traditional teaching process (N=3). One of the faculty member provided some answers for this problem:

Yani oradaki deney prosedürünü anlatımı genel olarak bizim labda yaptığımız olduğumuz için ben biraz üstünden daha iyi de tabii anlatılabilir ama orada biraz daha monoton anlatma kısmı da biraz tercihli durumda yani bu bilgi videosu, burada hani şey olmasın aynı standartta olsun, aynı şartta olsun, benzer şekilde olsun falan düşüncesiyle herhalde. Yani iyi buluyorum oradaki videoların anlatım şeyini çünkü biz zaten bizim kendi prosedürlerimizden alınma, bizim labta anlattığımız şekilde yapılıyor tabii birçok farklı şekilde çoğu aslında değişti şu anda, biraz geri kaldı onlar ama onlar güncellenecek, düzelecek, büyük ayıplar, eksiklikler vesaire yok. Var bazı hatalar falan ama o kadar mutlaka olacak bir şeyler yani (P #2)

I mean, since the expression of the experiment procedure on there is the one that we do in our lab, it can be explained better of course. But a more monotonous style is preferred on there I mean, it was probably made by thinking like "This is an informing video, it should be at the same standards or circumstances, it should be similar…"etc. I mean I find the explanations of the videos well because they are already taken from our own procedures, it is done in the same way we explain it in the lab. Of course many things have changed now, they got a bit behind but they will be updated, fixed. There are no big mistakes, deficits or such. There are some deficiencies but there should be some anyways (P #2)

As the same strategy applied in teaching process in laboratory environment, the teaching process on the videos were also standardized based on the teaching process in the laboratory. The second issue was related with the content knowledge provided in videos. While some participants mentioned that the resources should only provided the procedural knowledge (N=17), some participants argued that the resources could provide sufficient instruction related with the content knowledge (N=17). One of the students remarked this issue as:

Şöyle; bunu zaten izleyenlerin çoğu böyle ben bir şey bilmiyorum, anlamadım, video izleyerek daha da anlayım gibi bir düşünceyle bu işe giriyorlar. Fakat video tam olarak o kesime hitap etmiyor. Zaten daha önceden ne koyacağınızı biliyorsunuz. Biz sadece fotoğrafını çektik, işte videosunu çektik alın bakın gibi olmuş. Biraz daha tanımlayıcı nitelikte olsa çok daha iyi olur. Göstermeden çok, daha çok anlatmaya yönelmesi daha iyi olabileceğini düşünüyorum (SME #10)

Most of the people watching this start this like: "I don't know anything, I didn't understand anything, I can understand better by watching the videos" etc. But the video is not exactly for that class. You already know what you will put beforehand. It's like "We only took the pictures, we took the videos, look at *it". They could be more descriptive. I think that they would be better if they would focus more on telling than showing (SME #10)*

As mentioned in cognitive outcomes section, the resources did not provide theoretical knowledge about the experiments. Many students supported to have some content knowledge in videos but especially some faculty members and teaching assistants did not have a mutual perception with students on that issue. They supported to remain the current teaching process in videos, which mainly focused on procedure of the experiments. They thought that the students could learn the content knowledge in the classroom from the teaching assistants. One of the faculty members explained this perception as:

Hani böyle ilk başta video ve animasyon, işte o kendi yaptığı animasyon şeyiyle deneyleri en azından pratik olarak nasıl yapacağını anlaması, kafasında onun da soru işareti kalmaması sonra mesela laba geldiğinde de işin o trikle esas bilgi kısmını laboratuvarda edinmesi belki daha iyi olabilir. Önceden çok fazla malzeme olduğunda çok fazla bilgi olduğunda sadece görsel şeyin dışında belki öğrenciyi uzak mı tutabilir? (P #3)

It could be better for the students to understand how the experiments are done at least practically by means of videos and animations and the animation things they do on their own, not to have a question mark in their minds, then when they come to the lab, to acquire the actual knowledge part in the lab with that trick. Would it keep the student far away when there were too many materials, too much information except for the visual stuff? (P #3)

As faculty member pointed, adding theoretical knowledge could prevent students from preparing for the course. Some teaching assistants also argued that the purpose of the videos was to provide procedural knowledge but they supported to add some key knowledge, which triggers how and why questions related with the content knowledge.

4.4.5.1.1.1.1.3 Update problem

The final criticism about the videos was updating the resources. Some participants noticed that for some experiments, chemicals or the procedures were changed in the laboratory environment (N=19). One of the teaching assistants mentioned this problem as:

Şu anda da yararlı olduğunu düşünüyorum ama güncellenmesi gerektiğini de düşünüyorum tabii ki sonuçta her sene şey yapılıyor işte kitaplar değişiyor güncelleniyor ya da bir şekilde bir şeyler değiştiriliyor. Öğrenciler eskiyi izlediklerinde, laba geldiklerinde zorluk çekiyorlar. Biz bunu böyle görmedik diyorlar. Hani onların güncellenmesi gerektiğini düşünüyorum (TA #5)

I think they are beneficial now too, but I believe they should be updated of course, everything changes and is updated every year in the end and something changes somehow. When the students watch the old ones, they have difficulty in the lab. They say "We didn't see it like this." So I think they must be updated (TA #5)

For the update problem, the faculty members had not negative perceptions because for most experiments, they did not apply major changes for the experimentation process. However, the responsible teaching assistants still needed to inform students about the changes. Derived from the observations and interviews, students had some conflicts while implementing the experiment in one week. The chemical was changed and the last step of the procedure was not included in the resources. Students mentioned these changes in the classroom and they did not have major problems while doing the experiment.

4.4.5.1.1.1.1.4 Language quality

Related with the teaching process, while some participants defined the language as easy to understand and professional, two of them pointed some problems about the quality of language as follows:

Türkçe olanlarda araya çok fazla İngilizce kelime katılıyor. Fark ettin mi bilmiyorum, o güzel değil biraz daha tam Türkçe seslendirilse iyi olacak o diye düşünüyorum. Yani İngilizcelerde sorun yok da zaten mesela test tüpü diyor ya da test tüp, yani deney tüpü Türkçesi. Rahatsız ediyor biraz, çocuklar için de kötü hani yarın bir gün gittiğinde test tüp dese, Türkçe bir yerden mezun olmuş kişi bakacak çocuğa öyle. Ben de aynı şeyi yaşıyorum bazen, söyleyemiyorum Türkçesi'ni biri tam Türkçe biri tam İngilizce olsun o güzel olabilir (TA #9)

There are so many English words being added near the Turkish ones. I don't know if you have noticed but it's not good and I think it would be better if they were vocalized in Turkish. I mean there is no problem with the English ones but for example it says "test tube" or "test tüpü", in Turkish it is "deney tüpü". It is disturbing a bit, it's also bad for the students. When, one day, they go *somewhere and say "test tüpü", a person who has graduated at a Turkish school will stare strangely. Sometimes I experience the same thing, I can't say the Turkish word. It could be nice if one is entirely in Turkish and one is entirely in English (TA #9)*

4.4.5.1.1.2 Simulation

Like videos, participants had some positive and negative attitudes toward simulations. To begin with the positive attitudes, the first issue was related with the visual quality. Visual quality caused one of the major contradictions about simulation environment (N=13). Some participants described the visuals as attractive like a student mentioned below:

> *Malzemeler falan zaten gerçek boyutuymuş gibi gösteriyor. Onda sıkıntım yok da, kenarda beliren o yaşlı profesörü o çok tatlı. Biraz çocuksu ama bence hoş bir mizah olmuş, bence öyle çocuksu kalması da güzeldi (SMI #14)*
>
> *The materials etc. already seem like in their real sizes. I don't have a problem with that, the old professor that appears on the side is so cute. He/She ? is a bit childish but I think it's a nice humor, it's good that it stayed that childish (SMI #14)*

For the second issue, some participants found the teaching process as enjoyable (N=8). One of the students expressed her experience as like game environment:

> *Simülasyon kötü değildi bence, yani zevkli, daha iyi öğrenebilirsin ama gerek yoktu. Oyun gibiydi. Ama iyiydi bence, gayet güzel hazırlanmış (SME #17)*
>
> *I think the simulation was not bad, I mean it's fun. You can learn better but there is no need. It was like a game. But it was fine, very well-prepared (SME #17)*

Also for the third issue, the practical experimentation opportunity also attracted some of the participants compared to video (N=7). One of the research assistants explained this experiement as to interact and participate in the process:

> *Interaction var orda. Hani en azından öğrenci oradan bir sürükleyip, onu oraya aktarıp falan bir şeyler yapabiliyor ki bu da güzel bir şey. Çünkü izlerken de siz bir yere kadar konsantre olup bir yere kadar takip edebiliyorsunuz. Ama simülasyonda siz, kendiniz bire bir işin içine dahil olduğunuz için uygulamada yapabildiğiniz için kesinlikle etkin (TA #10)*

There is interaction there. At least the student can drag something from one place to another place, which is a good thing. Because when you are watching it, you can concentrate on it and follow it to a certain extent. But in the simulations, since you yourself are in the business, and since you can practice it too, it is absolutely effective (TA #10)

Correspondingly, the simulation also helped to show the details in the procedure which could help to understand the procedure (N=5). One of the students explained his perspective as follows:

Simülasyon biraz daha güzel çünkü parça parça gösteriyor, o parçalara odaklanıyor. Mesela ağırlık vesaire ölçeceğiniz zaman ağırlığı sanırım direk tartı aletinin üzerinde gösteriyor. Siz anlıyorsunuz evet bir parça, bir parça hani daha net bir şeyde görmenizi sağlıyor. Görsel yaparken evet gerçeklikte böyle olacak, simülasyona geçtiğinizde evet parça parça olması, hani sıralamasını aklınıza daha güzel bir şekilde yerleştiriyor (SME #16)

Simulation is a bit better because it shows things in parts and focuses on those parts. For example when you are going to measure a weight, I think it shows it directly on the weight. And you understand, yes one part, one part, it enables you to see it more clearly. On the visual part, yes it will be like this in reality, in simulation it's in parts, so it places the order in your mind in a better way (SME #16)

In addition three participants mentioned that the simulation was a powerful tool to provide feedback through learning activities.

4.4.5.1.1.2.1 Criticism about the simuations

Participants mostly had negative experiences in simulation environment. Related with these experiences, there were some major critics, which were divided into four categories.

4.4.5.1.1.2.1.1 Visual quality

Contrary to the positive ideas, most participants did not consider the visual environment as successful. For these participants, the environment had a simple interface and visuals. They argued that the visuals were not appropriate for the university students (N=15). A student elucidated this argument as:

Simülasyon güzel ama biraz dediğim gibi… şöyle anlatayım, biraz daha sanki çocuksu geliyor bana, biraz daha basit geliyor. Aslında biraz daha böyle gerçeğe yaklaştırma şansımız olursa daha da güzel olabilir şey açısından, görseller açısından. İçerik olarak gerçekten güzel ama biraz daha grafik olarak, görsellik olarak daha gerçeğe yakın olursa aslında bence daha da iyi olabilir. Daha çok dikkat çekebilir yani diğer öğrenciler açısından (SMI #19)

The simulation is good but just like I said…Let me tell put it this way: it seems a bit childish to me, looks simpler. Actually if we had the chance to take it closer to the reality, it could be better in terms of visuals. It's really good in terms of the content but it would be better if it were graphically, visually more realistic. And it can attract other students' attention more (SMI #19)

In addition, some participants criticized the environment as not being real regarding the experience (N=6)

Interviewee: *Laboratuvarda yaptığımız hani birazcık zorlayıcı oluyor mesela 25 cm filan almak zorlayıcı*

Interviewer: *Gerçeğe yakın değil mi?*

Interviewee: *"Ya gerçek hayattaki hata paylarını göz önünde bulundurmadığı için, daha çok teorik üzerinden gittiğini düşünüyorum ben simülasyonların (SME #3)*

Interviewee: *What we do in the lab is a bit hard, I mean taking 25 cm and stuff is hard.*
Interviewer: *Isn't it realistic?*
Interviewee: *I think simulations are more theoretical since it doesn't take the margin of error in real life into consideration*

4.4.5.1.1.2.1.2 Quality of teaching process

Similar with the arguments about the teaching process in videos, the simulations did not promised higher expectations (N=15). As mentioned in the procedural knowledge part, the steps were simple and obvious so that the simulations failed to provide sufficient knowledge:

Açıkcası simülasyon biraz basit gibi. Biz yapmıyoruz da o bize yaptırıyor. Bir sonraki adıma geç. Şunu mesela çubuğu almak zorundayım, kasaya dokunamıyorum mesela. İlla ki fare gidip çubuğun üstüne tıklıyor. O da zaten belli oluyor. Hani sorusu verilmiş sınav gibi oluyor açıkcası. Cevabı verilmiş sınav gibi oluyor. Ben tam şey yapamıyorum (SME #10)

Actually simulation is a bit simple. We don't do it but it makes us do it. Go to the next step. I should, for example, take the stick, I can't touch the case ?. The mouse goes and clicks on the stick. And it's already obvious. It's like an exam whose questions are given away. It's like an exam whose answers are given away. I can't exactly… (SME #10)

Related with this problem, simulations also suffered from the lack of user engagement so that they did not provide any application opportunity for the participants (N=6). The dialogue between both researcher and student indicated this issue:

Interviewee: *Şöyle oluyor şimdi normal videoyu izlerken hanı orda sunu yapıyor bunu yapıyor şöyle koyuyor ya simülasyonda tutup mesela sürüklüyorsunuz hop hop hop hop bir anda bitiyor deney*

Interviewer: *Anladım, sana çok bir şey kalmıyor aslında*

Interviewee: *Yanı evet hanı tut şunu şuraya koy sadece öyle tamam yanda görünüyor mesela atıyorum NACL diyor hanı orda o var deney tüpünde belli onu oraya boşaltıyorsun su geliyor onu oraya boşaltıyorsun hanı biraz kalıyor hanı hepsini şuraya yapacağım falan diye (SME #3)*

Interviewee: *It goes like, while watching the video normally, it does this and it does that, it puts that like this, you hold and drag things in the simulations for example, poof poof poof poof then suddenly the experiment is over.*
Interviewer: *I see, so there isn't much left for you to do*
Interviewee: *I mean yes, it's like hold it, put that over there, okay, it's seen on the side for example and let's say it says NACL, it's there in the text tube obviously, so you pour it down there, water comes out and you pour it down there, there is some left and you say "I'll put it all over here" etc (SME #3)*

The aim of the simulations was to improve the user engagement within the experiments but it seemed to accomplish this aim regarding the participants' ideas.

4.4.5.1.1.2.1.3 Technical problems

There were some major technical problems in the simulation environment. Many participants suffered while learning the simulation environment at the beginning (N=14). One of the teaching assistants narrated her experience in the environment as below:

Şimdi işte en basitinden pipeti oradan mouse ile alıyorsunuz, solvent şişesinin içerisine daldıracaksınız. Ama o oraya denk gelmiyor, o oradan solventi *çekemiyorsunuz falan. Bir kere ben de öğrenciyim, yüksek lisans öğrencisiyim, ben sıkıldım ve bıraktım, yarıda bıraktım yani. Çünkü çekmiyor bu bunu diye. Yani o biraz da geliştirilebilir. Aslında çok güzel bir fikir olmuş. Ama halen bir eksiklikleri var yani (TA #3)*

Simply you take the pipette with the mouse from there, you will dip it in the solvent bottle ? But it doesn't fit there, you can't take the solvent from there. For one thing, I'm a master student, I got bored and left it, I quit in half of it I mean. Because it doesn't take things from stuff. I mean it could be developed a bit, as well. Actually it's very good idea. But there is still some deficits to it (TA #3)

As seen in the comment above, technical problems caused to be bored in the environment. Some participants mentioned that they did not continue to use the simulations after those problems. Another mentioned problem was related with the lack of guidance for how to use tools in the environment (N=6).

Bir kere basta anlayamadım simülasyonu nasıl programlamışlar, tutup çekiyorum hiçbir şey olmuyor, yapamadınız falan diyordu ondan sonra öğrendim belli bir şeyin içine getirince yapıyormuş (SME #3)

At first I couldn't understand how they programmed the simulation, I hold and drag stuff but nothing happens, it says "You couldn't" etc., then I learned about it, it does that when you drag in onto something particular (SME #3)

4.4.5.1.1.3 Video vs Simulation

Regarding video and simulation, the participants were asked about their preferences between them. Most of the participants determined their initial choice as video (N=24). One of the students declared her preference as:

Interviewer: *Sen anladığım kadarıyla videoyu daha çok beğenmişsin.*

Interviewee: *Tercih ederim, evet çünkü gerçek bir şey görüyor çocuk, ne yapacağından daha çok haberi olur çünkü bunlarda bazı şeyleri göstermek de çok zor, gerçekten hani nasıl yapacağız bilmiyorum (TA #9)*

Interviewer: *As far as I understood, you liked the video better.*

Interviewee: *I prefer that, yes, because the student sees something real, she would be more aware of what she is going to do, because it's hard to show some stuff on these, I really don't know how to do that (TA #9)*

As seen in the usage profiles of the videos and simulations in use part, most of the students preferred to use the videos to simulations. Regarding this issue, participants had different ideas to explain. For some students, the practical application was not necessary before the laboratory because they would apply the process in laboratory environment (N=4). A student mentioned her reason as:

> *Bir kere kullandım, sanki oyun oynuyormuş gibi oluyor☺ Ama vakit kaybı olabilir aslında, çok da gerek yok, nasıl olsa yapacağız biz burada (SME #17)*
>
> *I used it once, it feels like you're playing a game☺ but it can be ta loss of time actually, there is not much need, we will do it here anyway (SME #17)*

Other reason to prefer videos was related with the necessity of the simulations. Some participants expressed that the videos met their expectations for the course.(N=20) A student explained this issue as:

> *Simülasyon birazcık fazla kalıyor galiba hanı videoyu da zaten ihtiyacın olduğunda karşılayabiliyorsun gibime geliyor simülasyon ne bilim çok fazla zaman harcıyormuş gibi geliyor aynı zamanda (SMI #3)*
>
> *Simulation is too much I guess, I mean it feels like you can you see the video when you need it already, I don't know, it's like it makes you send too much time at the same time (SMI #3)*

The teaching assistants had some concerns about the use of the simulations. Some of them pointed that they were not sure about students who had lack of interest and preparation for the course. They had some concerns that the students would not use two resources for preparation. Another reason was related with the technical problems in the simulation environment. As mentioned in the simulation section above, the technical problems directed people to use videos.

On the contrary, for some students, the simulations could be more beneficial (N=5). Self-application opportunity could make users more careful on process. A student explained this issue in her comment below:

> *En azından mesela izlerken ben yapmam gerekmiyor, onda kafam dağılabilir ama öbüründe ben kendim bir şey yapmaya uğraştığım için daha bir dikkatli olabilirim mesela (SME #12)*

While watching, at least I don't have to do it,? but in the other one I could be more careful because I'm trying to do something by myself (SME #12)

Moreover, simulations could also be beneficial for some experiments, which needed more detailed procedural explanations. Therefore, regarding preferences of the participants, most of them preferred to use videos but they thought that both videos and simulations should be offered for different learner types (N=30). A student explained his reason for this issue as:

İkisi de olmalı çünkü bazı insanlar hani izleyerek öğrenebiliyor diğer insanlar uygulayarak öğrenebiliyor bence ikisi de hani farklı ben mesela uygulayarak öğrenmeyi daha çok tercih ediyorum videolar daha uzun ve sıkıcı olabiliyor bazen, bence ikisi de olabilir hani bazı insanlar tamam görerek öğrenebilirler ama bazıları dokunarak öğrenebilirler o çubuğu ordan oraya ittirmek daha öğretici olabilir (SME #1)

I think both of them should be on there because some people can learn while watching, some other people learn by practicing. I think both are different, I for example, prefer learning by practicing. Videos can be longer and more boring sometimes, I think both can be there. I mean some people can learn by seeing it but some can learn by touching. Pushing that stick from there to another place can be more instructive (SME #1)

In here, it was important to notify that these participants suggested offering the resources after making some improvements. While some participants were satisfied with the current resources, most of them suggested changing ineffective parts.

4.4.5.1.2 Suggestions about the OERs

The participants provided some suggestions about the resources. Some of them were general suggestions, which were valid for both video, and simulation and some of them were specific to each resource.

4.4.5.1.2.1 General Suggestions

The first suggestion about the resources remarked the trend for mobile applications. Some participants proposed to adapt the resources on mobile platforms to increase the accessibility (N=4). One of the students pointed this issue as:

Sınav öncesi veya sınav sabahı bilgisayardan çok hadi açayım da kimya labına gireceğim diyeceğini zannetmiyorum. Telefon için yapılmış bir uygulama olsa ve bunun bir aplikasyonda yapsalar, bence daha elverişli olur. Eminim yapabileceklerde vardır yani (SMI #8)

I don't think I would say "I should open it, I will go to the chemistry lab later today" before the exam or in the exam morning. It would be more convenient if there was an application for mobile phones or if they did this in an application. I'm sure there are some people who can do this (SMI #8)

The second suggestion was to provide an attractive environment (N=6). One of the teaching assistants provided suggestions to change the experiments or chemicals in the following comment:

Evet, hani yani ne bileyim ilgi çekici bir şey yapmamız lazım ya deneylerin bir iki tanesini değiştirebiliriz belki kullandığımız kimyasalları değiştirebiliriz, daha renkli cicili bicili şeyler hoşlarına gidiyor bunlar biraz küçük oldukları için yani heyecan verici olabilir (TA #9)

Yes, for example we should do something interesting, we can either change one or two of the experiments or we can change the chemicals that we use, they like more colorful cutesy things since they are a bit younger, it might be more exciting for them that way (TA #9)

The third suggestion was related with the content knowledge on the resources. Some students offered to add some key information about the chemicals and procedure:

Bence şu eklenebilir; mesela deneylerin birçoğunda tüp ısıtmıyorlar, tüpün nasıl ısıtılması gerektiği gösterilebilir mesela ya da tüpün şu şekilde ısıtmayın, bu şekilde ısıtırsanız şu olur mesela, o gösterilebilir yani görsel olarak ya da asitle su karışımı mesela, asitle suyu karıştırmak için önce biraz su eklersin, sonra asidi yavaş yavaş eklersin, sonra yeniden su ekleyip istediğiniz hacme getirirsiniz. Fakat önce aside su eklerseniz direkt patlar. Bunu mesela gösterirsiniz bir videoda (TA #4)

I think this can be added: for instance in most of the experiments, they don't heat tubes, they can show how to heat a tube or they can instruct like "Don't hear the tubes like this, if you heat them like this, this would happen" etc. visually. Or a mixture of acid and water for example. You add a bit of water first, in order to mix acid and water, then you add the acid slowly, and then you can add water on to that again and you can create the volume you like.

However, if you add water on the acid, it directly explodes. You can show this in a video for instance (TA #4)

4.4.5.1.2.1.1 Suggestions for Video

Participants provided some suggestions for the videos in order to solve the problems in the environment.

4.4.5.1.2.1.1.1 Wide-angle shooting

The first suggestion pointed that some participants wanted to see the experimenter in the video, which could be provided through wide-angle shooting (N=6). One of the students explained her reason for this suggestion as:

> *Mesela deneyle simülasyonu ayırmak için deney yapan kişinin gözükmesi daha canlı bir ortamda hani, çünkü deney yaparken yaptığın mimik bile akılda kalıcıdır. Mesela orada diyor ki işte eldiven kullanılması gereken bir şey. Dikkat edin hani, bu yakar dediğinde bile hani o göz şeyi sende daha bir etki bırakır (SMI #11)*
>
> *For example, in order to separate the experiment from the simulation, the person who does the experiment should appear in a more realistic environment, because while experimenting even a mimic is catchy. For example they say "It is necessary to wear gloves" on there. When he says "Be careful, it burns", that eye thing leaves a more permanent effect on you (SMI #11)*

As mentioned ın the quotation above, it was important to catch the mimics of the experimenter for some students.

4.4.5.1.2.1.1.2 Update the resources

As mentioned in the video section, the videos did not contain the new parts in the experiments. While most participants did not interpret this issue as a major problem, some participants compared this issue with other resources (N=7). Thus, they suggested providing new information in resources. One of the students explained her reasoning as:

> *Sonuçta şimdi diğer dünyadaki üniversiteler baktığımız zaman onlar bile sürekli güncelliyor işte ders çekimlerini yine hani ben MIT yi sürekli takip ediyorum mesela onlarda da böyle 90 lardan kalan videolar vardı şimdi*

yenisini çekmişler çok daha güzel bir sistemle bence onlar yenilenebilir (SME #9)

When we look at other universities in the world, they constantly updates themselves, like their course films. I always follow MIT for example, they had videos from the 90s, they have recently filmed new ones. They can be renewed with a way better system I think (SME #9)

4.4.5.1.2.1.1.3 Add theoretical knowledge

Some students suggested offering some theoretical knowledge in videos. While most of them agreed to add only key knowledge (N=17), which did not extend the length of the video, some of them suggested creating videos for theoretical knowledge of the experiments (N=14). One of the students gave some suggestions for this type of videos from other practices:

Orda öncekiler çok kötüydü (MIT OCW) hani bayağı dediğim gibi eskiydi ama şimdi bu iTunes un uygulamasında tek tek yenilemişler mesela orda bir video 50 dk falan sürüyordu eskiden ama şimdi konuları bölmüşler 10 ar dk yapmışlar daha da hani kısa baslıklar mesela önceden chapter chapter oluyordu çok uzun oluyordu zaten ders çekimiydi hani hoca tahtada anlatıyor siz de öğrenci gibi izliyorsunuz ama şimdikinde bir tane beyaz bir kâğıt üzerinde anlatıyor ve başlıkları kısa kısa ayırmış 10 ar dklık mesela ben bütün konuyu izlemek istemiyorum sadece bir noktada sıkıntı var işte onu açıyorum soru çözüyor kısacık konuyu anlatıyor ve bitiriyorum hepsini izlememe gerek kalmıyor (SME #9)

The previous ones there were awful before. (in MIT and OCW) I mean as I said, they were old but they renewed it on the application of iTunes. In there, a video would take 50 minutes or so in the past, but they have now divided the topics and they made each 10 minutes. They wrote shorter titles, for example they used to be chapter by chapter and they were too long, they were class films already in which the teacher lecturing on the board and you would watch it like a student. But in the new ones, the teacher teaches it on a white paper and he/she has divided the titles shortly, talks for 10 minutes etc. I want to watch the whole topic. For instance I have difficulty in one part only and I open that one and the teacher solves a problem there, explains that topic briefly and I finish it, there is no need for me to watch all of it (SME #9)

4.4.5.1.2.1.2 Suggestions for Simulation

The suggestions were provided under three issues based on the participants' comments in the interviews.

4.4.5.1.2.1.2.1 Improve user engagement

The first suggestion revealed that there was a need to improve the quality of the teaching process in simulations (N=18). One of the teaching assistants suggested a strategy in order to increase the user engagement in the process.

> *Bütün deneyin malzemeleri olabilir en başta ve sonuna kadar kendi yapabilir. Yani masanın üstünden basamak basamak, step step kendi seçer bu şunu gösterir. Neyi hangi sırayla yapması gerektiğini mesela anlatır. Çünkü şu andaki, hali hazırdaki simülasyonda zaten size bir şey açılıyor ve orada ne yapacağınız çok belirgin zaten. Yani onu ona dökeceksiniz. Çok bir şet düşünmesine gerek kalmıyor ve düşünmediği gibi de ne kadar etkili oluyor. Yani onun yapıp yapmamış olması ne kadar etkili emin değilim. Belki hani çok ufak işte bir şeyi önce koyması gerekiyordur diğerinden belki o aklında kalır simülasyonda. Yani dediğim gibi anca bu kadar bir etkisi olabilir. Ama tıpkı simülasyonu izledikten sonra deneye girdiğinde yapacağı gibi malzemeleri alır yani simülasyonda da örneğin bir masası vardır. Masasının üzerinde bütün malzemeleri vardır ve kendi başına baştan sona kadar yapar. O bence çok daha etkili olur. Daha karmaşık olur tahminim ama çok daha etkili olur. Hakikaten tek başına yapıp yapamadığını öncesinde görmüş olur (TA #8)*

> *They could present materials for the whole experiment in the beginning and she can do on her own until the end. I mean, she can pick everything from the table by herself, step by step, and she tells about what she should do and with which order she should do it for example. Because now, in the current simulation, it already presents everything for you and what you are supposed to do is very obvious on there. I mean, you will pour this down into that. There is no need to think too much and it is not effective as well. I mean I'm not sure how effective it is whether she has done it or not. Maybe, it is too small thing, I mean, she should put something into something before another, maybe she will remember it. I mean as I said, it can affect to this extent at most. But if, just after watching the simulation, he gets the apparatus that he will use in the experiment, I mean for example he has a desk in the simulation and there are all the equipments on the desk and he does that experiment from the beginning til the end, it becomes more efficient. I guess it will be more complicated but it will be more effective too. He will see whether he can really do it on his own or*

not, beforehand (TA #8)

4.4.5.1.2.1.2.2 Provide feedback

The second suggestion was related with the feedbacks in the environment. In some parts of the procedure, the system gave some feedback to guide the users but these feedbacks were mostly related with the technical details in the procedure like warning about to fill the water appropriately (N=10). Therefore, the participants offered that the simulations could provide some informative feedbacks about the procedure. These feedbacks also defined to be simulative rather than result-oriented.

> *Belki yanlışlardan bahsedilebilir hani işte bunun yerine bunu kullansaydınız bu şekilde olacaktı falan deyip anlamamıza daha böyle pekişmesinde yol açacak şeyler olabilir (SME #5)*
>
> *Mistakes could be mentioned, as it could be better if you used this rather than that which could lead to understand and to consolidate the information (SME #5)*

4.4.5.1.2.1.2.3 Provide assessment

Some participants also suggested adding assessment parts into simulations. This application could help to implement the procedure more consciously (N=26). One of the students explained his suggestion from this perspective:

> *Simülasyon belki şey olabilir hani, bir aşamaya geçtiğimizde, bunu neden yaptığımızla ilgili sorularda sorabilir. Sadece maddeleri birbirine ekleme gibi değil de, hani biraz daha test usulü orada küçük bir pop quiz tarzı bir şeyde olabilir (SMI #13)*
>
> *In the simulation, there can be details like, when you've come to a new stage, it can ask us questions about why we are doing that. A little test on there, like a pop quiz kind of a thing would be better, rather than adding those substances into one another (SMI #13)*

4.4.5.1.3 Laboratory Book

Regarding the instructional materials in the system, laboratory book and the resources, they both had some features, which created some advantages over each other.

4.4.5.1.3.1 Advantages of Laboratory Book

The first advantage of laboratory book was related with the conceptual knowledge. The laboratory book played an important role for providing conceptual and procedural knowledge about the experiments. When the participants were asked about their preparation routine, most of them used the laboratory book for some reasons. The first reason was having conceptual information for the experiments (N=9)**.** One of the students explained this advantage below:

> *Yanı ocw de soyle deneyı nasıl yapacagımızı gosterıyor ama ne bılım hanı konu hakkında da bır cok fazla bır sey uzerınde durmuyorsunuz yanılmıyorsam ne bılım bır bılgılendırme deneye ıste sunları katıyoruz sunu soyle yapıyoruz bunu boyle yapıyoruz deneyın nasıl yapılacagını ama kıtapta hanı ıste bunları bunları su konuya dayanarak su formullerı kullanarak yapıyoruz seklınde anlattıgı ıcın hanı daha ogretıcı gıbı gelıyor bana (SMI #3)*

> *In OCW videos, they show us how to do the experiment but I mean you don't emphasize on a specific topic if I'm not mistaken. For example there can be an informing conversation. It shows which things to add, which way we do it, how we should do the experiment etc. But the books show us we do those things with which formulas based on what, so I find the books more instructive (SMI #3)*

Related with the conceptual information, the major motivation to prefer the laboratory book was having information about the questions on the quizzes (N=8). One of the students focused on this issue by saying her preference between the instructional materials:

> *Ikısı de yarı ayrı gereklı cunku vıdeoda konuyu ogrenıyorum ama quızden not alamıyorum yanı vıdeo bıraz daha laba yonelık kıtap bıraz daha puan almaya yonelık yanı kıtaba bakmazsam ne formul kullanacagını bılmıyorum ıste quızde neler cıkacak bılmıyorum vıdeo benım ıcın sadece o gun neler yapacagız hangı konudayız bu konuda, kıtapsız olmaz (SME #9)*

> *Both of them are necessary in their own ways because I learn the topic in the video but I can't get a good grade in the quiz, so the videos are based more on the labs; but books are based more on the gradings. I mean if I don't read the book, I don't learn which formulas to use and the answers of the questions in the exam. Videos only tell me about what we will do that day or what topic we are covering. So we can't do without the books (SME #9)*

Similar with the results of the use and the academic performance outcomes sections, the quizzes had an essential effect on motivation for using the instructional materials.

For some students, the second advantage of the laboratory book was to be usable and accessible every time. In addition, the students were more eager to use printed materials than online materials (N=12). Seven students declared that they would prefer to use online version of laboratory book. One of the students explained his reason as:

> *Elimin altında kitabın olması güzel bir şey. Mesela derse gelmeden önce şurada bir şey vardı ne olmuştu dediğimde kitabı açıp bakarım. Bir de zaten kitap hem puanlama olarak, kendi üstünü çizdiğimiz şeyler olarak labda kullandığımız için telefonu kullanamayacağız. (18:31) içinde bilgilerim de olsun (SME #16)*
>
> *It's good that I have them in my hand. For example before entering the course, when feel unsure about a thing, I always open the book and read it. Also, since we use the books for grading and as things we write on during labs, we can't use our phones (SME #16)*

4.4.5.1.3.2 Criticisms about Laboratory Book

The procedure part in the laboratory book was described as too long and complicated to understand the experiment. One of the major preferences of the resources, which was mentioned in the use part, caused by the quality of the expressions in the laboratory book (N=5). While most of the students complained on this issue, some research assistants also worried about. One of the teaching assistants focused on this problem derived from her experience:

> *Mesela lab manuelde sıkıntılı olduğu kısımlar vardı. Ben hani onları hep vurguladım, arkadaşlar hani kitabınızda böyle gibi anlaşılıyor ama öyle değil böyle yapacaksınız, onlar mesela giderilmeli bence (TA #7)*
>
> *There were some problematic parts in the lab manual. I always told about them, I said "Friends, the book says this but you should do this instead of that", these problems should be eliminated (TA #7)*

The second argument about the laboratory book was related with the lack of visuals. A teaching assistant explained this problem in the following comment:

Kitapta çok şekil olmadığı için çocuk tabii anlamıyor, onu koy, bunu koy ama burada görsel bir şey gördüğü zaman faydası oluyor. Kitabı da görselleştirebilirsek iyi olur aslında onu da konuşmak istiyorum dönem sonu toplantısı olursa. Çünkü çok yazı var ve çocuklar onu anlamıyor hani (TA #9)

Since there are not so many figures in books, the students don't understand some stuff, we say "Add this, add that" but when she sees something visual, it helps better. It would also be good to visualize the books, I would like to talk about this if there would be a end-of-semester meeting. Because there are too many written parts and the students don't comprehend them very well (TA #9)

4.4.5.1.4 Laboratory Book vs OERs

The major comparison between the laboratory book and resources focused on the quality of the content knowledge. There were contradictory ideas about this issue that some participants considered the laboratory book provided more detailed information than the resources.

Mesela videoyla kitabın arasındaki fark o. Kitapta gerçekten çok detaylı ve güzel anlatıyor (SME #19)

I think that's the difference between the videos and the books. The explanations in the books are more detailed and better (SME #19)

However, some participants defined the resources more understandable than the laboratory book. A student mentioned his experience in the following quote:

Deneyi anlamama etkisi oldu. Yani kitaptakinden daha net, daha açıklayıcı oldu. Kitapta prosesi gereksiz uzatıyor bence ama videoda o gereksiz detaylara takılmadan direkt süreci gördüğüm için daha anlaşılır oldu (SME (SME #14)

Videos have helped me understand the experiments. I mean they are more clear to understand than the book, and more explanatory. I think the process is unnecessarily long in the books but videos have been more comprehensible since I was able to see the process itself directly without tripping over the details (SME #14)

Most of the students suggested using both laboratory book and the OERs (especially video) together. They considered that each material focused on different features so that they completed each other (N=30). One of the students explained this preference as:

Aslında ikisi de farklı şeyler biri pratik biri teorik olduğu için hani ikisini aynı anda kullanmak daha iyi bence hanı kitapta dediğim gibi sadece teorik bilgiler var kitapta görsel yok zaten böyle bir sıkıntısı var kitabın, sistemde de ocw de de şey yok teorik bilgi yok ikisi birbirini tamamladığı için ikisini de kullanmak gerekiyor (SME #4)

Actually each of them is a different thing. Since one is theoretical and the other one is practical, I think it is better to use both at the same time. Like I said, there are only theoretical knowledge in the books and not visuals, they have such a problem. And in the system, on OCW, there is not any theoretical knowledge and both complete each other so one should use both (SME #4)

In this system, the students were dependent to laboratory book for teaching and learning processes in the course environment and all the components in the system operated based on the information ın laboratory book. Thus, it was not a realistic approach to eliminate the laboratory book from the system. This approach required some changes in teaching methods and strategies. In this setting, some participants offered alternative ways for using resources instead of laboratory book.

Bana göre kitap yerine kimya labını kimya dersi ile paralel süreçte götürebilseler, kitaba çok ihtiyaç olduğunu düşünmüyorum. Sadece bizim raporları alabileceğimiz bir yer olursa ve bu videoları daha erkenden biz izleyebilecek biz imkâna sahip olsak, yani şimdi mobil uygulama olsa bir sonraki gün labım olduğunu hatırlatıcı vs. bu tarz şeyler yapılabilse ki telefondan bunu da artık çok rahat yapabilirim. Ben hani lab periyodumu girdiğim zaman benim haftaya hangi labım olduğunu söyler. Bende onun videosunu izleyip rahatlıkla girebilirim (SMI #8)

I think, if they could continue chemistry lab with the chemistry lessons in the same process instead of the book, nobody would need the book. But I think it would be better for us to only have a place to get the reports from or if we could have the chance to watch these videos earlier. I mean even if it's a mobile application, it should remind me that I have a lab the next day etc. If it could do such things, which is easier for me to do on the phone now. When I enter my lab period on the phone, it should tell me which lab I have next week. So I can watch that video and enter the lab more comfortably (SMI #8)

4.4.5.1.5 Online vs Printed Material

Related with the comparison between laboratory book and resources, the participants were asked their preferences about online and printed materials. In here, the online materials were defined as the online versions of printed materials such as e-book, journals, syllabus etc. Some participants were eager to use printed materials rather than online materials (N=12). Some of the students explained their preferences as:

> *Basılı kaynağı tercih ederim, çünkü online kaynağı, her an bakma şansım olmayabilir, internet erişimi olmayabilir fakat kitabı her zaman istediğimde de yanımda olduğu için bakabilirim (SMI #13)*

> *I prefer printed sources because I might not have the chance to check the online source any time, I might not have the access to Internet. However I can read the book whenever I want because it's with me (SMI #13)*

Accessibility created one of the major concerns about the online resources. Some students did not prefer to leave their studying habits. The second reason to select printed materials was easy to focus on the printed materials rather than online materials. A student clarifies her reason as:

> *Basılı bir şey tercih ederim. Online de benim çalışma disiplinim olduğum için. Elektronik bir ortamda her zaman başka bir şeylere kayma lüksü olduğu için, kitap daha odaklayıcı geliyor (SMI #11)*

> *I prefer something printed because I don't have a studying online discipline. There is always a possibility to get distracted in an electronic environment, so I find the book more focusable (SMI #11)*

On the contrary, some participants declared to prefer online resources (N=7). They mentioned many reasons for the preference, which began with the cost of the materials. Higher prices caused some problems for students as one of them pointed as below:

> *Kesinlikle. Çünkü kitabın sahtesini alıyorum, okunmuyor. Orijinalini alıyorum, çok pahalı. Özellikle fizik kitabı şöyle bir kitap, 65 lira vermek insanı üzüyor. Onun pdf'sini indirdiğim zaman aynı şeye denk geldi sanırım, yani hem kitabı görebiliyorum. Aslında bilgisayarımı her yerde taşıyamadığım için birazcık sorun oluyor tabletim olmadığı için. Telefona inmiyor maalesef. Boyutları biraz fazla olduğu için. Ama bence faydalı. Bilgisayara ulaşabildiğim yerde kullanıyorum (SME #15)*

> *Absolutely. Because I buy a copy of the book, I can't read it. I buy the original book, it's too expensive. Especially the physics book, it's very sad to pay 65 Turkish liras for it. When I downloaded the pdf version of it, I guess it was that figure was almost the same, I mean I could see the pages at least. Actually it's*

a bit of a problem because I don't have a tablet and I can't carry my computer around everywhere. And it's not downloadable on the mobiles since its size is too big. But I think it's beneficial. I use it anywhere I can get a computer (SME #15)

The second benefit of the online resources was mentioned as being user-friendly and ergonomic. A student expressed his comment in the quote below:

Bir de şöyle; buraya atıyoruz, kaybolma oluyor, yanlış yazma olma durumumuz oluyor, karalıyoruz, çirkin bir görüntü oluyor, çünkü tükenmez kalemle yazıyoruz. Zaten her yerde bilgisayar var, herkesin de laptopu var artık (SME #19)

For one thing, we toss it over here, it gets lost, we could write wrong stuff, we scribble on it, it looks unappealing because we take notes with pens. There are computers everywhere already and everyone has a laptop now (SME #19)

Regarding user preferences, most of the participants suggested providing both printed and online resources because having different choices was important and beneficial for them.

4.4.5.2 Benefits of the OERs

During the interviews, several benefits of the resources were mentioned and these benefits were provided under four categories.

4.4.5.2.1 Comfortable Experimentation Process

The most mentioned benefit was related with the experimentation process. The participants described their process as more comfortable by the use of the OERs (N=17). One of the students explained this issue from her experience:

Kullanmadığım zaman böyle bir tereddütle, sıkıntıyla geliyorum genelde. Çünkü partnerim de izlememiş olursa böyle biraz sıkıntı yaşıyoruz, sora sora öğrenmeye çalışıyoruz. O da bayağı vakit kaybına neden oluyor (SME #15)

When I do not use it, I usually come in a terrible, distressed situation. If my partner does not watch it, we have a bit of trouble, we are trying to learn by asking. It also causes a lot of time lose (SME #15)

Some participants also portrayed their experience as to be more relieved and less concerned in the course environment (N_s=5, N_{ta}=3). One of the teaching assistants shared her experience as:

> *Bir de dediğim gibi ben o baştaki deneylere hiç giremediğim için çok daha kendime güvensiz girmiş, çok daha rahatsız hissederek girmiştim zaten kendimi. O videoları izlemek beni çok daha fazla rahatlattı. Yani bence, benim için çok etkili oldu diyebilirim (TA #8)*
>
> *And as I said, since I did not enter those labs in the beginning, I entered the labs feeling very insecure, I felt uncomfortable. Watching those videos helped me feel more comfortable. So I can say that they have been very effective for me (TA #8)*

In line with the comfortable experimentation procedure, the OERs also helped some participants to increase their self-confidence (N=14). One of the students mentioned his perception about this issue:

> *Bir kaç kere böyle tüpü elimden kaydırıp kaçırsam da, kaydırıp düşürsem de…Biraz da o dediğim gibi o isin biraz gerçeklik boyutuyla alakalı kısım. Ama dedigim gibi, şunu ben biliyorum, zaten çift olarak yaptığımız için ben videoyu izledim, simülasyonu da yaptım ne yapacağımı biliyorum, onun için yapabilirim diyor yani insan gitmeden önce (SMI #19)*
>
> *Even though my hand slipped a few times in the lab, or I dropped flask, it's also about the actuality. But as I said before, after watching the videos, one says "I know it, I watched the video and we did it as partners, I completed the simulation and I know what I will do so I can do it" before entering the lab (SMI #19)*

The participants also mentioned that the OERs made them more self-reliant in the experimentation process (N_s=7, N_{ta}=4)). They expressed that knowing the procedure of the experiment minimized the reliance on assistants. One of the teaching assistants narrated his memory about this issue:

> *Bence video yeterli oluyor eğer izliyorlarsa gerçekten ki izleyen öğrencilerimden ben gerçekten de onun etkili olduğunun farkına varıyorum. Yani 2 partner seklinde deney yapıyorlar ya oradan mesela partnerlerden biri izlemiş oluyor ama mesela diğeri izlememiş oluyor. O mesela partnerine anlatıyor işte bunu şöyle yapacağız şeklinde bana gerek olmadan. Hani bu güzel bir şey çünkü orada öğrenci ile uğraşırken ben her*

zaman yetemeyebiliyorum. O açıdan güzel oluyor, ben mutlu oluyorum en azından kendi adıma (TA #2)

I think videos should be enough, if the students are watching properly of course. I really reckon that they are effective when I see my students who have watched them. I mean they do the experiments as two partners, one of the partners usually watch it before entering the lab but the other doesn't. So the one who has watched it tells about it to his partner like "We are going to do it like this…" and they do it without needing me. And that's a good thing because I may not be helpful there when struggling with those students. From this angle it is good, at least I am happy about this on my behalf (TA #2)

4.4.5.2.2 Preparation for the Course

The second mentioned benefit of the resources was related with the preparation for the course. First advantage for the preparation was about helping the participants for practicing many times (N=7). One of the students referred to this advantage to see the experiments many times:

En azından anlayamadığım deney olursa bakmak için elimde kaynak var. Hem böyle geriye dönüp de mesela bu deneyi yapma fırsatım her zaman olmayacak. Videoyu izleyip nasıl yapıldığını bir daha görebilirim (SME #18)

At least I have a resource that I can watch when I don't understand something in an experiment. If it weren't for it, I wouldn't have the chance to go back and do that experiment all the time. But now I can watch the video and see how it is done again (SME #18)

For the second advantage, the resources helped some students to make easier their understanding of the experiment in the preparation time (N=15). Related with the criticisms about the laboratory book, the OERs offered shorter explanation of experiments. One of the teaching assistants shared her comment for this situation as:

Kitapta 10 stepte anlatılan bir şeyi çocuk şurada 2 saniyede seyredip, aaa ben böyle bir şey yapacakmışım ya da çok kolaymış diyebiliyor. Ya ben bile diyorum öyle söyleyeyim. Bir sayfalık şeyi şurada 3 saniyede yapıveriyor (TA #9)

A student can say "Oh, this is what I'm going to do, it's very easy" after watching that thing over here in 2 seconds, even though it is told in 10 steps in the book. Or even I say that. He just does a one-page process over there in 3 seconds in the video (TA #9)

4.4.5.2.3 Different Learning Experience

The third benefit of the resources was providing different learning experiences. Some participants argued that both video and simulation addressed some benefits for visual learners (N=16) and to visualize the process especially for novice learners. In addition, simulations could help some learners who need some practical applications in their learning process. One of the students defined her learning style as:

Materyalin yararı öğrenme sekline bağlı biraz. Ben çok direk dümdüz okuyunca çok anlayamıyorum. Bu şekilde daha faydalı oluyor ama herkes ihtiyaç duymayabilir tabi (SME #11)

Whether the material is beneficial or not depends on the student's way of learning. I can't understand it well when I just read that thing. But the videos are more effective, even though not everyone might need them of course (SME #11)

4.4.5.2.4 Teaching Practices

The last benefit of the resources was explained form the teaching assistants' perspective. As mentioned in the use part, the teaching assistants used the resources for their teaching practices. In here, the benefits of the resources on their teaching practices were provided. Some teaching assistants (N=6) stated that the resources helped them to show the process of the experimentation as one of them explained below:

Benim açımdan yararlı, şöyle yani ben prosedürü okuyorum evet tamam bu böyleymiş diyorum ama videoda izleyince ha tamam bunu böyle yaptırırım, yapmalarını söylerim diye kendi kafamda hani nasıl o deneyi anlatacağımı kurabiliyorum (TA #2)

In my case they have been effective, I mean I read he procedure and say "Oh, okay, this is like that" but when I watch it in the video I say "Alright,

> *I will have the students do it that way, I will tell them to do this" and I can visualize in my mind how I am going to present that experiment (TA #2)*

In addition, the resources also helped the teaching assistants to direct students about some details in the procedure (N=4):

> *Karşıdaki öğrenci şey bekliyor, gerçekten otoritesin, senin bütün deneyleri biliyor olmanı, bütün saçma sorularına da cevap verebiliyor olmanı bekliyor. Hani bazıları kasıtlı soruyor, onu da fark ediyoruz biz ama bazıları gerçekten bilmediği için soruyor. Dolayısıyla gerçek anlamda cevap verebilmek için şeyi görebilmek, yani diyor ki hocam bunu, atıyorum yani öyle bir örnek yoktu da, hızlı mı dökeyim, yavaş mı dökeyim? Şimdi ben hani orada okuduğum zaman hızlı gibi ama falan diyorum bazen çünkü föyde çok sıkıntılar var bence. Dolayısıyla videodan onu izlediğimde bakıyorum, ha evet bu şekilde döküyormuş diyebiliyorum. Dolayısıyla benim hani çocuğu yönlendirmem de daha rahat oldu onu izlediğim zaman (TA #7)*
>
> *The student in front of you expects that you are the real authority, that you know all the experiments and that you should be able to answer all the silly questions. I mean some of the students ask them on purpose, we get that, but some ask only because they don't know the answer. Therefore, in order to be able to answer them, you need to see the video. For example he asks "Madam/Sir, should I pour this slowly or fast?". I read it on there and say "Fast" but sometimes there may be problems on the leaf. So after I watch that on the video I can say "Oh okay, it's poured like this". So it is easier for me to instruct the students after watching the video (TA #7)*

As mentioned in the quotation above, knowing the details in the procedure could also increase the authority of the teaching assistants. Moreover, the resources were useful for some teaching assistants to see different teaching styles as one of them stated as:

> *Söyle olabiliyor bazı şeyler, nasıl yaklaşıyor olaya. Yani bazı soyut kavramları anlatmak güç oluyor. Nasıl anlatmış ve nasıl yaklaşmış oraya gibi dinlemek güzel oluyor (TA #6)*
>
> *Sometimes it is hard to understand how you should approach stuff. I mean, it's hard to talk about some abstract concepts. It is nice to listen to it on the videos, how they have talked about it and how they approached to things (TA #6)*

4.4.5.2.5 Language Choices

Other benefit of the resources was to provide language choices. Language choice was an effective criterion to use and select the resources. Some participants mentioned the benefit of this opportunity as to understand the experiments easier with their native language (N=7). One of the students described the benefit of the language choices on her learning process:

> *İngilizce de deneyi kullandığımız, yani prosedüre baktığımda, kitapta yazan prosedüre baktığımda İngilizceyi dinleyince daha rahat anlıyorum ama Türkçe de kavramama yardımcı oluyor deney esnasında (SME #15)*
>
> *After I take a look at the procedure in the book, I can understand it better when I listen to it in English but during the experiments, using Turkish also helps me comprehend things (SME #15)*

4.4.5.3 Necessity of the OERs

Beside the benefits and criticism about the OERs the question raised from the interviews and observations: Did it worth to create, design and provide these resources? Did money, work and cost cover the effects of the resources in reality? Most of the participants supported to provide the OERs whether they needed them or not, but this number decreased when talked about the necessity of them. Some participants stated that they could handle the course without the OERs but they provided more comfortable and beneficial experimentation process. (N=16) One of the teaching assistants clarified this issue from her experience:

> *O konuda hani % 100 gerekli ya da % 100 gereksiz diye bir şey söyleyemem. Çünkü izlemeden de onlar yani çocuklar izlemediği zamanda o deney yapılıyor. İzlediği zamanda o deney yapılıyor. Hani ne oluyor, izledikleri zaman kendileri daha bilinçli olarak deney yapıyor. Ben daha az soru almış oluyorum onlardan hani bunu nasıl yapıyoruz şeklinde ama dediğim gibi % 100 gerekli, kesin gerekli gibi kesin asla olmamalı gibi bir şey söyleyemem. Olsa iyi olur diyebilirim (TA #2)*
>
> *I can't say that it is 100% necessary or 100% unnecessary when it comes to talk about that because even when the students enter the labs without watching the videos before, that experiment is done anyway. But when they come after*

> *watching them, they do the experiment more consciously. I get fewer questions from them than usual about how a certain thing should be done but as I said, I cannot say something like it is 100% necessary or that it shouldn't exist. I can say that it would be better if it stayed (TA #2)*

On the other hand, some participants were not eager to provide the OERs, which did not have a dramatic effect on students' performance (N=4). One of the faculty members criticized this issue in his comment below:

> *Dolayısıyla o şeyler kritik, video koyacaksak videolarda kritik bir düşünce şeyi ben bunu nasıl yaparım, şöyle yaparım, böyle yaparım diyemiyorsa bir öğrenci onu niye koyayım ki oraya? (P #4)*

> *So, those things in the courses are critical things. If a student doesn't ask "How do I do it, I do it like this, like that", why would I put that over there? (P #4)*

However, some participants had accurate comments that they advocated to offer these resources in the system. One of the research assistants also shared his perspective about the necessity argument based on the possible benefits of the resources:

> *İlgili öğrenciyi bence bir tık üste çıkarıyordur kesinlikle. Dolayısıyla yararlı bir şey, bir öğrenciye bile hani fazladan bir şey öğretebiliyorsa bence yararlıdır. Bir materyalin olması da bence bir sıkıntı teşkil etmiyor. Hani en kötü ihtimal kullanmazsınız olur biter ama hani kullanma ihtimaliniz de var. Kullanırsanız da oradan bir şeyler alma ihtimaliniz var, kendiniz geliştirme ihtimaliniz var, eğitimciliğin temeli de bu zaten. Eğitimci demek bu demek, bir şeyler öğretebilen demek, o yüzden hiçbir materyal bence hiçbir zaman şey değil, fazla değildir yani. Tabii bunu düzgün bir şekilde organize edip sunmak gerekiyor kullanıcıya hani video var deyip de seçin arasından deyip yapmak da çözüm değil. Bunu belli bir düzen içinde yapmak lazım ama olması her zaman iyidir (TA #10)*

> *It (a video) absolutely elevates the student one scale up. So it is a beneficial thing. Even if it teaches only one student an extra thing, it is beneficial. I think it's not a problem that there is one more material. In the worst case you choose not to use it, but you might use it as well. And if you use it, you can learn something from it, or you can improve yourself, which is the very foundation of being an educator. An educator means this, a person who can teach something, so no material is ever too much. Of course it should be organized properly before offering it to the users. It is not a solution to say "There are the videos" and "Choose between them" for example. It must be done in a specific order but it's always good to have an extra resource (TA #10)*

4.4.6 Satisfaction of the Learning Experience (Output)

As analyzed in the outcomes section (academic performance, cognitive, affective and psychomotor skills and activities), the system met some expectations of the participants. Mentioned in the inputs section, the students and instructors had diverse expectations related with each outcome.

In order to analyze in detailed, the first expectation was related with getting higher grades in the course. Regarding the academic performance section, most of the students had satisfactory grades to pass the course. However, the OERs did not meet the expectations of students. They did not provide enough information for the quizzes and reports.

Regarding the second expectation, the students and teaching assistants were satisfied to have some practical skills for the experiments. The OERs were successful to provide visual information about the chemicals and equipment. These features could be considered as one of the successful effects of them. Therefore, most of the students observed in this course were mainly interested with implementing the experiment so that this feature usually met their expectations.

For the third expectation, some students wanted to know and understand the procedure of the experiment before each experimentation. Presented in cognitive outcomes section (procedural knowledge in detailed), the OERs also had powerful effects on this expectation. Most of the users mentioned that OERs helped them to understand the procedure in a simple way. In addition, they aided the users to visualize the process in their mind. Thus, for this part, students had satisfactory experiences in the system. However, this success was not valid for the interpretation and comprehension part. Some students expected to have some critical thinking skills and interpretation in their learning process; neither the resources nor the system met the expectations of this small part of students. Therefore, for these students, the experience was not satisfactory. Moreover, from the instructors' perspective, the system should provide abilities to interpret and analyze the information but according to the outcomes, this desired output seemed to far from expected.

4.5 Summary of the Results from System Theory Perspective

The general chemistry laboratory course as a system has some components, which include some relationship between each other. While these components were defined as people (students, teaching assistants), instructional materials (laboratory book, videos and simulations), course environment (teaching and learning activities), teaching method, assessment, and also the policy practices; the instructional materials (especially videos and simulations) were analyzed based on its usage and effectiveness within the interactions inside the system. Through the system theory perspective and three models of display, Figure 4.3 displays how the components of the system affect the use and integration of the OERs into the system (This figure could be examined in correspondence with Figure 3.6 showed in process model on methodology part).

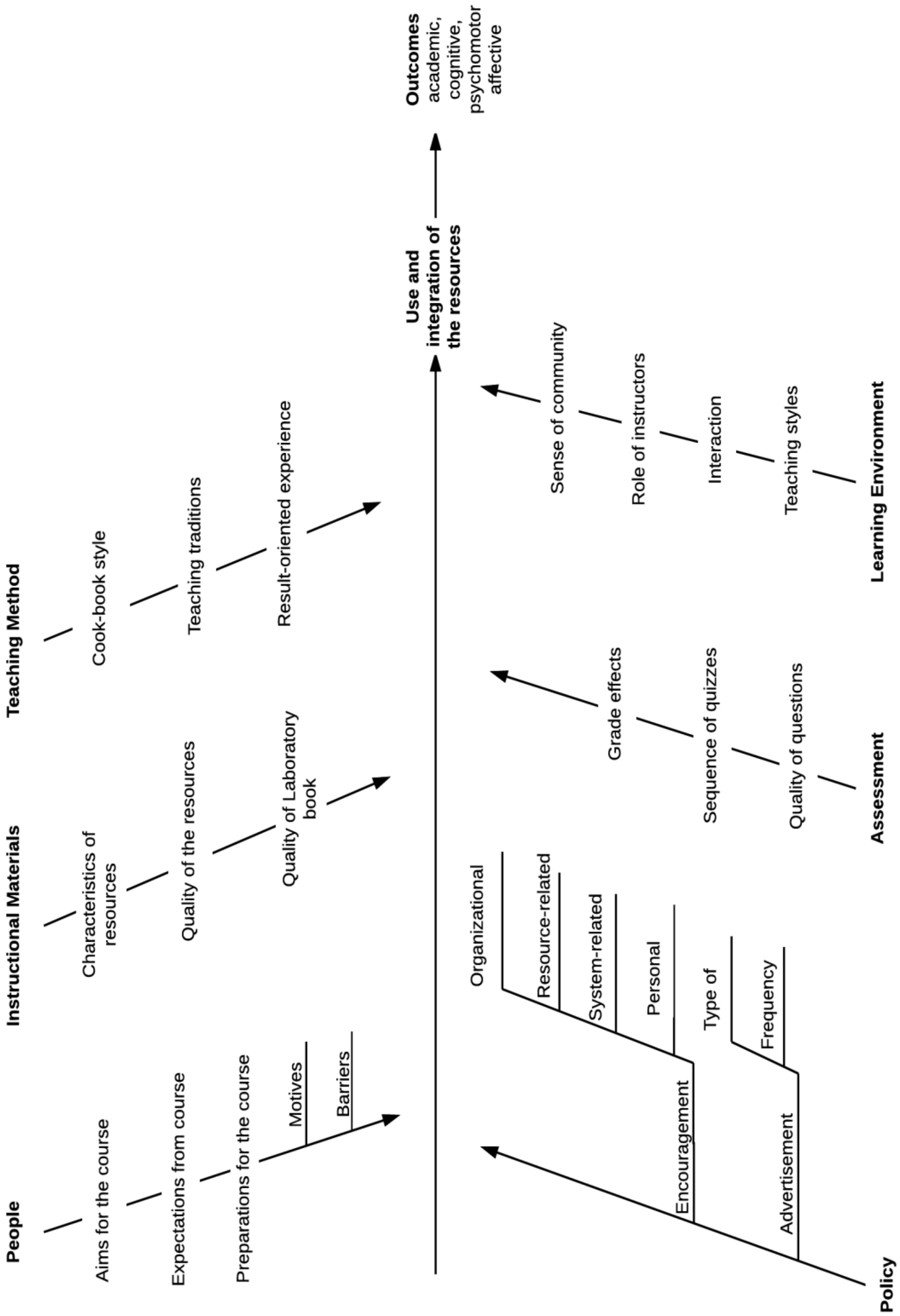

Figure 4.3 GCLC components' effects on use & integration of OERs into system

Related with the components of Figure 10, four themes emerged throughout the study as; utilization, adoption-implementation, policy and outcomes. While the first three themes (utilization, implementation and policy) were analyzed in correspondence with the first research question, the last theme (performance outcomes) was examined related with the second research question of this study.

First research question results:

Regarding the first theme, *use of the OERs*, three factors emerged related with how and why students use of the OERs for their chemistry laboratory course:

- *Preparations for the course:* The students who used the resources spent more time for preparation and had more focus on procedural knowledge beside theoretical knowledge. However, half of the students were spending less time for preparation (less than 30 minutes) because of pre-quizzes and reliance on teaching process in the classroom.
- *Usage profiles:* While the qualitative data displayed that more than half of the students were aware of the OERs (65.3%) and among them, half of the students used the OERs for their laboratory course (56.3%). However the total usage level of the OERs was found as 38.6%. On the other hand the usage profile in two departments as participants in the qualitative part of this study showed that 57 students (among 94 students) and 5 assistants used the resources at least one time in the first semester; in the second semester this number was 68 students (among 108 students) and 2 assistants. The groups who were given regular information about OERs had sustainable usage profiles in two semesters. It is also significant to note that most of the users were preferred to use the videos rather than simulations in both qualitative and quantitative part of the study.
- *Motives to use the OERs:* Related with the preparation, some intrinsic and extrinsic motives were defined form student's side which to be prepared for the course, to prefer visual resources than printed materials, to be informed and to finish the laboratory earlier. For teaching assistants, the motivators were

much more related with improving their teaching experience. Related with sustain to use OERs; the prominent factors were effects on their performance and having regular information related with OERs.

- *Barriers to use the OERs:* On the contrary to the motives, some barriers were determined through four categories (student-related, course-related, resource-related and external factors) to use the resources and the prominent ones were lack of interest for the course, lack of time, not to be informed properly, complexity of the experiments and poor fit of the OERs with their purposes. Similarly, questionnaire results displayed that the students who did not used the resources were not aware of them, no need for resources, and lack of time to use the OERs.

Regarding the second theme, *implementation*, four components in the system and problems related with these components were emerged in the environment:

- *Teaching process:* When the teaching method was mentioned to direct the students for more result-oriented experimentation (cook-book style), the interaction between the students and teaching assistants were insufficient.
- *Experimentation process:* In consistent with the inferences form teaching process, experimentation process was also defined as result-oriented. The number and quality of the questions, which were mainly comprise the next step of the procedure within the lack of interpretation of the theoretical knowledge, also indicated the quality of students' activities. While role of TAs were more prone to direct students on exact answers, the quality of questions displayed the lack of preparation and the reliance on TAs on each procedure of the experiments.
- *Assessment process:* Regarding the problems in the assessment process, the quality of the questions in the quizzes and reports and the sequence of these assessments were mainly mentioned problems. While the questions in the quizzes affected some students' preparations routines, their reliability and

validity to assess the individual performance was also a concern for some students.

- *External factors:* Nonparallel lab course and main lecture and the frequency of the lab course were found to affect the students' learning activities and usage behaviors of OERs.
- *Integration of the resources:* What the OERs offer for this problems were also found insufficient but the course could be redesigned within the integration of the resources particularly in the teaching and assessment processes.

For the third theme, *policy*, the user and academic culture about OERs in the world and the awareness about METU OCW could provide some insight about the user profiles of OERs in chemistry laboratory course.

- *User culture of OER:* Most of the students and teaching assistants were aware of OER and used at least one of the universities resources for their own learning and development. The most preferred characteristics of the resources were popularity, reliable source, scope and parallelism of the content.
- *User culture of METU OCW:* OCW awareness was found very low and some barriers were examined to use the OCW as lack of awareness, insufficient content, lack of interest and prejudices about the university.
- *Academic culture of OER:* While professors were prone to use different kind of OERs in their courses, they did not have any attempt to share their resources. Related with this issue, they were mostly unaware of openness policies and practices to share their resources.

Related with the policy practices about OERs, the support for the resources were also determined a critical component for the current and future use and improvements of the OERs. However, four categories emerged as somehow affecting the use and integration of the OERs:

- *Personal issues:* Some personal issues (academic concerns for personal development and adaptability for educational innovations) could prevent faculty members and teaching assistants to give sufficient support for OERs
- *System-related issues:* Some system-related issues (attitude to general chemistry course, interrelation between faculty members and the system) were found significant to indicate insufficient support for the OERs.
- *Resource-related issues:* The concerns about the quality of the resources possibly influenced the encouragement given by the faculty members.
- *Organizational issues:* Some problems in organizational issues within the department (lack of sustainable practices, decision-making process and financial support) could hinder the support for the OERs.

Second research question results:

The students' expectations from the course were diverse which pointed three domains; cognitive (to have knowledge about the experiment, to interpret the information given), psychomotor (to have some practical skills for conducting the experiments, to finish the experiment), and affective (to get satisfactory grade to pass the course, to get enjoyment) that some of them were met by using the OERs. Related with the expectations, the effect of the resources on users' performance pointed four different categories in terms of academic performance, cognitive, psychomotor and cognitive domains.

- *Academic performance:* While some students' perceived academic performance increased with the use of the OERs, the grades of the students did not point significant changes.
- *Cognitive:* While the OERs helped the users to remember and visualize the process, they did not have significant influence on their conceptual knowledge and interpretation abilities during the experimentation process.

- *Psychomotor:* Students perceived their ability to recognize and use of the equipment and chemicals as more successful. OERs also helped them to finish their experiments earlier.
- *Affective:* Students experienced more comfortable and satisfactory experimentation process. The OERs also provided different learning experiences and language opportunities. However, the concerns related with the quality of the OERs and laboratory book and necessity of the OERs in this system was also critical for the future use and developments of OERs.

Therefore, while the OERs perceived as mostly successful by meeting affective (except getting higher grades) and psychomotor activities; they had some drawbacks for meeting the needs for cognitive domain. In addition, the OERs were perceived as supplementary and optional material in this case and some users had crucial criticisms about the necessity and quality of them. While most of the users were supporters to sustain to provide the OERs, they mostly suggested preserving the OERs with some improvements and developments to increase the quality of them.

As outlined above, in the following parts, each result was discussed in the light of research questions. In addition, how the components of the system have a relationship with each other and specifically with the OERs were highlighted.

CHAPTER 5

DISCUSSION AND CONCLUSION

The purpose of this study is to explore the use of open educational resources within science laboratory course context. Specifically, through two main research questions, the user profiles and behaviors (motivators and barriers to use the resources), teaching and learning activities, policy practices and performance effects were analyzed in order to portray a complete picture of how the OERs interacted with the components of the laboratory course as a whole system and which outcomes were attained by the use of OERs. Through these purposes, the experiences of students, teaching assistants and faculty members were analyzed to provide a complete perspective from the owners and clients of the system.

Case study method was followed throughout the study in order to have a detailed insight about the course (GCLC system). Within this case study, observations during the class, interviews and some documents were used in two semesters of data collection. While 24 participants were observed and interviewed for the first semester (18 students and 6 teaching assistants), 29 participants were selected for the same data collection methods in the second semester of the study (20 students, 5 teaching assistants and 4 faculty members).

5.1 MAJOR FINDINGS OF THE STUDY

As portrayed in the summary of the results section, GCLC system was selected to provide an insight for how to use and integrate OERs into chemistry laboratory courses and their effects on clients' performance in the system. In this part, how the results of the study were discussed through the interactions between the components of the system and their correspondence with the OERs were provided.

Related with the use and integration of the OERs, the policy practices, the components and activities in the classroom setting and usage behaviors were found related to provide a complete picture of the phenomenon.

The *policy practices*, which were categorized under personal, system-related, resource-related and organizational issues, which could also affected by the institutional practices, led to poor advertisement and encouragement practices for the use of resources which created some barriers for the use of OERs (external barriers – not to be informed). Moreover, as a personal usage barrier for use of OERs was also observed in the personal issues which affected policy practices about OERs. Policy practices also had a relationship with the components in the classroom setting (system-related issues - teaching process/role of TAs & organizational issues - non-parallel lab and main lecture) that teaching traditions could cause disconnection between professors and laboratory, which could minimize the support of OERs. Regarding resource-related issues, while the characteristic of OERs was defined as a both a motive or a barrier by some students, some drawbacks in the OERs prevented some professors to encourage them appropriately. In addition to that, the professors' academic culture related with OERs (particularly sharing experiences) and online resources were not promising and predicted to have an indirect effect on their support for the use of the resources. Moreover, the students' awareness of the OERs and online resources could induce the familiarity with this type of resources, the awareness about OCW and barriers to use METU OCW website also showed the effects of the institutional practices.

The *implementation* of course system, three processes as teaching, experimentation and assessment ordered the classroom setting. The OERs had somewhat minimal effect on the teaching process for teaching assistants and for students in the experimentation process and also it did not have a significant influence on assessment process. The motives for the use of the OERs were derived to get higher grades, this expectation mainly created a barrier for students which OERs had minimal place on assessment process. While the policy practices (especially system-related and organizational issues) displayed the problems in the teaching process (teaching traditions, teaching method), these processes had some problems internally. Teaching method and style induced weak preparation for the course and result-oriented experimentation process. This result-oriented experimentation also had a strong relationship with the role of the teaching assistants, who had a directive role during the course. This role also increased the number of questions asked by the students. While the interaction between the students and TAs were at an unsatisfactory level, this variable was found related with the students' expectation and attitudes toward teaching process. Moreover, unsatisfactory assessment also leaded to the lack of interaction between students and TAs. In addition, the quality of the assessment also caused for unsatisfactory preparation for the course. While the resources was a good tool for teaching assistants to improve their teaching practice, they did not provide a successful path for the problems in teaching, experimentation and assessment process. This low level of integration could cause the decrease for the use of resources.

Regarding the *use* of the OERs, while some motives and barriers were found as related with policy practices and implementation process of the course beside some personal and resource-related issues. Policy practices especially had an effect on external factors on motives and barriers to use the resources. Moreover, some policy practices also had similar pattern with the use of the OERs that both students and instructors had personal and resource-related concerns, which provided a barrier for use and support of OERs. From the implementation perspective, the teaching process caused an inverse effect for the use of resources. Moreover, the assessment process had both direct effect on motives and barriers to use the resources but its effect on barriers were more salient than the effects on motives. In addition, preparations for the course and the fit of the expectations with the OERs also had a strong relationship with the usage behaviors of the participants. Some students did not use external resources for their preparation because of relying on the teaching process and role of the assistants.

Usage behaviors directly affected participants' performances, which encompass academic, cognitive, affective and psychomotor outcomes. While the resources had mainly weak effect on students' academic performance, the affective and psychomotor outcomes were found more promising for the OERs. In line with these issues, derived from the expectations, some part of cognitive domain was highly achieved (procedural knowledge) while much higher tasks were found unsatisfactory.

5.2 DISCUSSION

5.2.1 RQ1. Which factors influence use and integration of OERs into chemistry laboratories?

In this section, the factors, which affected the use and integration of OERs, will be discussed through usage profiles, course components/dynamics and policy practices through three sub-research questions in this study.

5.2.1.1 RQ1a.Which factors represent the usage behaviors of OERs through the lens of preparedness for the laboratory course?

5.2.1.1.1 Usage Profiles & Preparation for the Course

The usage profiles showed that most of the students preferred to use OERs in their preparation process. Through OERs, videos were much preferred than simulations. This preference could be explained by three reasons: the quality of the simulations could lead the learners to videos or the videos could provide more authentic environment than simulations. Another explanation for this preference could be for these experiments; one resource could be enough for learners. These usage profiles also affected by the regular information given by the researcher that this kind of information could provide sustainable usage of these kinds of resources. In addition, the level of experience was also found explicit in this case, which was also supported by the barriers of usage, all experience teaching assistants, and some experienced students did not use the OERs. While the number of users in two semesters did not show dramatic differences, the users in the first data collection process was lower than the second semester. The participants in the first data collection process were on their second part of the course, General Chemistry II (CHEM 112) that was a following course of General Chemistry I (CHEM 111) so that the participants were more experienced on the laboratory course. This situation could be explained by the reference that this kind of multimedia could be more beneficial for novice learners than experts (Najjar, 1996).

The preparations for the course defined one of the major components in the course system, which indicated the students' behaviors and activities in the course environment. Results of this study indicated that nearly half of the students did not spare much time for preparation (max 30 min) before the class. Correspondingly, based on the study of Pogacnik and Cigic (2006), while half of the students took 20 min preparation time, 20% of them did not spend their time for any preparation. On the other hand, other half of the students who spend more time for preparation could be divided into two parts: the ones who used the OERs and who only used the laboratory book. Lab book users were not in high numbers, which indicated that the students preferred to use the laboratory book within the OERs, which could also give signs about the quality of laboratory book. Moreover, it was found that use of the OERs increased the students' preparation time and they also changed their studying behaviors that they did their preparation one day before the class and they spent much time within the use of the OERs. They also oriented students to focus on the experimental procedure beside theoretical knowledge because before the OERs they were mostly dealing with the theoretical part in the laboratory book. In GCLC environment, three factors emerged as negatively affecting the students' preparedness level:

Interest for the course: While different strategies were provided to enhance the preparation for the course in the literature through different tools as video, simulations or virtual laboratory, pre-lab activities (Reid & Shah, 2007), this study revealed that the components in the system should also be taken into consideration to enhance the students' preparedness level. Firstly, the students' interest for the course was found as an important indicator to prepare for the course. In GCLC system, majority of the departments (except chemistry engineering, molecular biology & genetics department) were defined as uninterested groups of students who possibly will not have chemistry related content in their future academic life.

Quality of the assessment: The interest for the course was also related with the aims of the students for the course mentioned in the third part of the study that the students' one of the major aims for this course was to get satisfactory grade to pass the course. This problem also pointed another problem in the system, quiz-directed preparation. In the system after the quizzes, there was not any other mechanism for students to be evaluated for their performance. Therefore, most of them only prepared for the course to get higher grades from the quizzes. Moreover, this study showed that the students who only prepared for the quizzes looked over the bold sentences in the laboratory manual. This situation highlighted the problem of the explicit information given by the laboratory manual and the students' studying behaviors. The easy way of studying for the quizzes made a decrease for the quality of preparation. From another perspective, the students could seek some important information to study among many information given in the laboratory book. In their study Berry, Cook, Hill and Stevens (2011) outlined the students' studying behaviors that the students only spared time to read the important knowledge due to their other responsibilities and priorities. Thus, the students could search for the information which best supported their aims and activities for the course.

Teaching method: The third problem was related with the teaching process in the system. The results showed that cover of the theoretical knowledge and the process of the experiments by the teaching assistants were found to have a negative influence on some students' preparation process. These students relied on the assistants' teaching process and assistance during the experimentation and they could complete the process in all circumstances with the help of teaching assistants and peers with the minimal preparation level. This inference is consistent with the study of Johnstone and Al-Shuaili (2001) who expressed that most of the students did not prefer to prepare for the laboratory because they aware that they could perform the laboratory in any case. Therefore, some components in the system could be redesigned to minimize the students' reliance on the processes in the course environment.

5.2.1.1.2 Motives and Barriers to Use

Students' preparation level for the course gave a clue about their usage profiles of the resources. Among them, they had different motives and barriers, which defined their usage profiles of the OERs.

For the *motives*, both intrinsic and extrinsic motives had an influence on usage behaviors; intrinsic part seemed to play a more vital role for the students. The *intrinsic motivators*, which enable students getting familiar with the environment and learning the experiment, were surprisingly high than expected for an optional use of OERs. This situation pointed that some students need a preparation before the course. Beside, this choice was also affected by the characteristics of the resources and problems in the laboratory book, which seemed to motivate student to use the OERs. Moreover, the visual feature of the OERs was found important especially for the content and process, which requires some practical skills. In addition, the language opportunity also helped students to understand the process better. In addition, interestingly, the use of the OERs by teaching assistants for teaching purposes was high than expected. Even if the OERs used by the teachers were defined mainly for preparing for their teaching and for getting new ideas (de los Arcos, Farrow & McAndrew, 2016), the teaching experience on this practical courses was found as an important factor to use the OERs in this case. Therefore, this showed that this kind of resources could be beneficial not only for students but also for other clients or owners in the system.

Beside intrinsic motivator, *extrinsic motivators* were also found important for the usage behaviors. Getting a satisfactory grade to pass the course, finishing the course earlier, and being informed seemed important to engage the students into the usage process. The results of this study also revealed that within a proper information and support, the optional use could be increased (experimental groups). Moreover, the regular informed groups (control group) also found to have a consistent usage profiles. However, within the proper information given to the participants, still half of the students did not prefer to use the OERs. One of the reasons for this could be the optional choice to use the resources. As seen in the result of the study Dalgarno et al. (2009), when the virtual laboratory provided as optional for students, the frequency of usage dropped to 29% (71% of the students did not prefer to use the virtual lab). This case was also valid for this study that some of the barriers could be driven by the optional use of the OERs.

Beside the optional profile of the OERs, other four *barriers* emerged in this study: interest for the course, effect of the resources on the performance, lack of information and lack of time. While the lack of information pointed some problems about policy practices in the system, the remaining three issues indicated major problems in the system environment as consistent with the literature as lack of awareness and lack of time (Phalachandra & Abeywardena, 2016). As mentioned in the preparation for the course, lack of interest was the main problem faced for the GCLC system and mentioned by the clients and owners of the system in many areas. As in the literature, interest problem is also valid for general chemistry courses. Sirhan and Reid (2001) criticized that the students who take General Chemistry course in University of Glasgow did not show enough interest and motivation for the course to complete their course credits. The reasons of this problem could be twofold: first, this course is a service course, which does not have a direct effect on students' academic life, and the second, the content of the course was not directly related with their future profession. The second barrier to use was found that some students did not prefer to use the OERs because it did not have a satisfactory effect on their understanding and academic performance. This could be explained by the nature of the resources. They did not provide theoretical knowledge which students could get this information from laboratory manual. In addition, there was not a clear mechanism to evaluate the performance of the students during experimentation, which possibly made the students to define the resources unnecessary in this system. Thus, this study showed that the activities, which were not associated with the assessment process, could not be accepted as sufficiently. Students tended to ignore the optional tasks if they are not related with the assessment and did not provide clear benefits for them (Dalgarno et al., 2009). Moreover, level of experience was also found essential for both students and teaching assistants that while all inexperienced assistants (less than 2 years experience) used the resources actively, the experienced ones only reviewed the experiment to get some teaching ideas. Finally, lack of time to spend for the OERs were defined that the course as a whole was not their primary responsibility for their academic life. Similarly, Rollnick, Zwane, Staskun, Lotz and Green (2001) also emphasized similar finding from their study that some students continue not to be prepared for the course by the lack of time through their other responsibilities and courses.

At last, from the results of this study, it should be noted that, most of the students *sustained to use* the OERs when they used the OERs at once even if the problems were valid in OERs. Their primary motivation for the use was the effects of the OERs on their performance. Therefore, if the students did not see the benefit, they would not use them again. As seen clearly from the usage table, the regularly informed groups through e-mails in each semester used the resource more than the other group of students. Informing could make the students to feel more responsible and encouraged for the course and they could pay more attention for the course.

Summary of this Section

- As for the preparation while the teaching process, the interest for the course and assessment had a negative influence on the quality of preparation, the laboratory book was found as not sufficient alone based on the user profiles and behaviors, which could support the integration of the OERs into the system.

- Personal issues, resource-related issues, system-related issues and external issues gave explanation about the motives and barriers to use OERs. These issues emphasized the relation of usage behaviors with the system components through system-related practices (teaching tradition, role of TAs, assessment), and relation with policy practices through external factors (advertising, encouragement issues, social influence). These usage profiles also displayed the importance of personal issues (interest, expectation from course, to be prepared for the lab) and resource-related issues (quality and content of the OERs) while considering the use of OERs.

5.2.1.2 RQ1b. What do lab assistants and students experience during the implementation of science lab courses, which could possibly related with the implementation of OERs?

The structure and components of the course system revealed many practices and also the problems related with these practices. In this study, the relation of course components with OERs was examined through two directions. While some of these problems in the components of the system possibly affected the use and integration of OERs; in some situation, OERs could provide solutions for these problems. For the first, the problems, which possibly affected the use of OERs, were teaching method, result-oriented teaching experience, role of TAs, quality of questions in quizzes and reports and frequency of lab course. For the second, the problems that OERs could possibly provide solutions were examined as teaching style, interaction, excessive questions, sequence of quizzes, and validity of reports. Therefore, in the following parts, these problems and solutions will be provided.

5.2.1.2.1 Teaching Process

Results of this study showed that three important problems emerged during the teaching process: teaching method, teaching style and interaction between the students and teaching assistants.

Regarding the first problem, *teaching method*, cook-book style (expository) teaching method was followed in GCLC system. While this method was still most preferred method in chemistry laboratories especially within larger number of students and departments (Johnstone & Al-Shuaili, 2001), it brought some problems for the quality of the activities in laboratories. In expository laboratory environments, students were defined to be less prepared and encouraged for the learning activities (Domin, 2007). As mentioned in the previous section, this method decrease the student preparation time and use of the OERs because they did not have much responsibility and function in the system. There are three different teaching methods (problem-based, inquiry based and discovery) criticized in the literature to provide more meaningful and learner-directed environment for laboratories (Donnelly, O'Reilly & McGarr, 2012; Powell & Mason, 2012) each of them had some pitfalls to manage and evaluate the students' learning activities in the environment. Especially for novice learners some inquiry type of laboratory teaching styles was also argued to increase the cognitive load of students so that direct instructional guidance with feedbacks were proposed to minimize the lost in the learning activity for novices (Kirschner, Sweller & Clark, 2006**)**. In GCLC environment, students had contradictory ideas about the teaching method which some of the students criticized their learning activities as inactive and non-satisfactory even if they were novice learners. Consequently, they mostly followed the instructions in the laboratory book and teaching assistants. In similar vein, the OERs did not provide satisfactory solutions for this problem. Both videos and simulations did not comprise any activities, which could orient students to think and interpret the content knowledge during the experiments. However, even if the non-traditional methods were claimed better than traditional method for interpretation of subjects or practical skills (Domin, 2007), these purposes could not be meaningful for non-majors who possibly looked for the real mechanisms of life (Hawkes, 2004). Meaningful process of learning could be related with the teaching method but could more importantly be related with the need and expectations of the students. In addition, the proper guidance could provide more meaningful learning activities, which pointed the design principles of the OERs.

For the second problem, *teaching styles*, each teaching assistants had an individual teaching style regardless of teaching the same content and experiment. Even if the departments' strategy to minimize the differences between the styles were operated, the discrepancy would be still valid. In addition, while some students felt more comfortable with the teaching process, some of them defined this process as non-essential and unnecessary. These students were mostly quick finishers who were driven by the purposes of finishing the experiments earlier. On the other hand, some students defined the teaching process as beneficial to cover the experiment before the experimentation process. In this line, it is important to hold the students' aims what the OERs offer for the teaching styles and methods is a critical question for the environment. As the teacher-driven environment, which students took a passive role in the process (Johnstone & Al-Shaulili, 2001) that should shift to learner-centered direction (Aufschnaiter & Aufschnaiter, 2007); the students did not need to use the external resources to prepare for the course. They mainly relied on the teaching process in the course even if the quality of the teaching process is obscure, it is important to define what the OERs provide to increase the quality of the teaching methods and style in the system. As mentioned in the use part, the teaching assistants used the OERs for their own learning and teaching process. However, for the teaching process, they mainly mentioned to use the resources while teaching the experimentation process rather than teaching the content. Therefore, how and why questions which students mainly search answers for the experiments were not received by the resources for both students and teaching assistants so that these thinking origins could only based upon the teaching assistants content knowledge and teaching skills. The OERs could minimize the problems of differentiation of teaching styles and make the teaching process easier but teaching the theoretical part still mainly devoted to assistants' content knowledge, teaching experiment (Herrington & Nakhleh, 2003) and awareness of the aims of students and themselves (Johnstone & Al-Shaulili, 2001).

The third problem, *interaction* between the students and teaching assistants during the teaching process, also showed consistent results with the lack of preparedness and teaching styles. As expected, when the students did not prepared for the course properly, they did not interact with teaching assistant in the teaching process. However, interestingly, for the students who prepared for the course also showed less interest and interaction for the teaching process. Two reasons were emerged within this study and also mentioned in the literature. Firstly, Pogacnik and Cigic (2006) defined one of the major problems in laboratory environment was to load students with excessive information before the experimentation. Similarly, this problem also raised in our environment. The teaching process was too long for students to grasp the meaning of the experiment and they lost their attention during the long procedure of the teaching process. Secondly, the students had different purposes for the course, which defined their thinking for the necessity of the teaching process. In addition, the thinking that they could learn the process in the experimentation because their theoretical knowledge would not be assessed again could drive this attitude. How OERs could provide a path for this problem was also an important issue the low interaction in the teaching process could display the need for more summarized or critical process of communication. Most of the students preferred to keep the current process to recall the experiment and process; OERs could shorten the recall process or make the teaching process more attractive for students. The interaction also showed the concerns about the quality of laboratory book, which students had problems to understand.

5.2.1.2.2 Experimentation Process

Regarding the experimentation process, which the OERs seemed to have more effect on, four major problems raised; result-oriented teaching experience, role of the teaching assistants, number of the questions and number of the students.

Result-oriented learning experience, the first problem in the process, the teaching methods and the activities seemed to direct students to be inactive learners in the environment. Beside students, some faculty members (teaching assistants and professors) were not satisfied with the experience of the students. In our study, which was conducted through expository style, the students displayed more result-oriented profile in their learning activities and they mainly focused on the procedure rather than the theoretical knowledge of the experiments in consistent with the findings of Obenland, Kincaid and Hutchinson (2014) study. Similarly, some studies in the literature revealed similar findings that the participants in expository style of instruction did not show an understanding of the underlying principles and activities in experiments but only following the instructions (Aufschnaiter & Aufschnaiter, 2007), students failed to combine psychomotor and cognitive domains and they performed the experiments by only following the directions in the manuals (DeKorver & Towns, 2015), and the laboratory environment mainly directed by focusing on completing the experiments while neglecting the students' learning activities and performances (Reid & Shah, 2007). These results are consistent with the idea that the laboratories function as "manipulating the equipment but not manipulating ideas" (Hofstein & Lunetta, 2004, p. 39). Beside the teaching method and lack of interest, the reason for the result-oriented activities could be the insufficient pre-knowledge, which could increase the cognitive load of the students as novices during the experimentation process (Kirshner, Sweller & Clark, 2006). As Windberg and Berg (2007) explained, if the students did not have sufficient pre-knowledge, they tended to focus on the procedure to survive in the laboratory environment. Thus, it is important to prepare the students' mind before the experimentation to enable them to combine the cognitive domain (theoretical and procedural knowledge) with the psychomotor domain. Moreover, it is essential to provide students the purposes and aims of the course clearly in order to minimize their cognitive load during the experiments. Thus, pre-lab exercises are important that especially non-major students could miss the aim of the experiment while conducting the experiment correctly (Chittleborough, Mocerino & Treagust, 2007). Similarly, Windberg and Berg (2007) also argued that the pre-laboratory exercises could guide the students about what the focus and point of the laboratory experiment, which could shape the students' purposes for the laboratory. As a pre-lab experience of the OERs, it is possible to say that the resources helped the participants to focus on the procedure beside the theoretical knowledge, because before using the resources, they mostly used the laboratory book to get some ideas about the quizzes. In this case, they were more prepared for the experimental procedure in the class. However, for a more meaningful pre-lab experience, some other information and guidance should be provided for novice learners.

The role of teaching assistants as the second problem in the environment; they had the primary role on laboratory to teach, manage and direct the students in the environment. The instructors' role should be a guide who triggers students' thinking skills by providing some answers for them (Cooper & Kerns, 2006; Herrington & Nakhleh, 2003) and their acts should be in line with the objectives of the course (Högström, Ottander & Benckert, 2010). However, in Cooper and Kerns (2006) study, it is obvious that the students in traditional lab defined the role of the instructors as leader rather than a guide. Correspondingly, in this study, while teaching assistants criticized themselves to have a more guide role than the leader role; most of the students were satisfied with the actual role of their assistants as a leader and responsive process. In this study, they faced with many problems in GCLC system, which challenged them to stay between the role of director or guide. They mainly were aware of the problems but their role was far away from expected. Their role was also found to negatively affect the students' preparation process because the students were aware to get answers for the process of experimentation. Thus, teaching assistants could direct the students rather than answering the questions related with the next step of the process, they could facilitate the students' asking behaviors to more meaningful questions. They could motivate the student by asking some leading questions to understand the experiment rather than only following the directions.

On the other hand, the role of teaching assistants brought another problem in the environment, *quality of the questions*. Hofstein and Lunetta (2004) reviewed several studies and they claimed that the interaction between the students and teachers are not in the desirable level, which mainly focuses on simple question-answer routine. Similar with this inference, the interaction between the students and teaching assistants were based on the same routine. However, during this routine, most of the students tended to ask informative rather than critical questions. They mostly rely on the teaching assistants responsive and directory behaviors. On the other hand, Domin (1999) and Rollnick et al. (2001) explained this problem from another perspective that the students have not sufficient time to actually think what they have done rather they mostly focused on to get the results rather than the experiment itself. Therefore, the lack of time could hinder their critical questions and they could not generate these questions not to miss the steps of the experimental procedure. This behavior could be eliminated by some questions in the preparation level within the resources or by the questions asked by teaching assistants in the experimentation procedure. Another explanation for the questions was also found to have a concern about the correctness of the experimentation process. In here, OERs could help to minimize the possible faults in the process, which showed the actual representation of the experimentation.

Excessive number of students, as the last problem, seemed to affect some activities negatively in the environment. While some groups had small sizes, some groups were facing the challenges of excessive number of students, which decreased the quality of the interaction between the students and their teaching assistants because assistants should share less time for each students for this scenarios. Similarly, Bruck and Towns (2013) mentioned this issues that the main challenges which faculty faced in the laboratory courses was the excessive number of students and diverse majors. In this part, the instructional resources remained critical to support the students' experimentation process. While the students followed the laboratory book in the process, some had problems to understand the information in the book so that the students could be allowed to use videos or simulations to follow the procedure of the experiment.

5.2.1.2.3 Assessment Process

Regarding the assessment process, quality of the assessments raised during the research process. First, the *quizzes* were criticized by the quality of the questions and the sequence during the course. Even the faculty members mainly aimed to standardize the questions in the quizzes; the questions were criticized as leading on memorization of the content knowledge. This result might not be surprising that while most of the assessments in many schools mainly comprise the first category in the learning taxonomy (remember/knowledge) (Mintzes, Wandersee & Novak, 2005). In addition, the possible questions were explicit in the laboratory book, which lead students to follow a quiz-directed study behavior that affected the use of the OERs. Also, the quizzes at the beginning could make some students to be relieved for the following parts of the course. Their knowledge and understanding were not be evaluated at the end of the course so that their primary purpose was to pass the quizzes with a satisfactory grade. Beside quizzes, the *reports* were also criticized by the quality and validity. Reid and Shah (2007) mentioned that many students were not happy on dealing with the report, which only covers to write the results of the experiments. In consistent with this study, some of the students evaluated the report as a burden, which does not include their interpretation of the experiments.

There were also some problems regarding the validity of the individual assessment and collaborative working. In the study of Shibley Jr. and Zimmaro (2002), they asserted that collaborative group of working decrease the students' question asking behaviors and also alleviate the freeloaders' behaviors in the group working. However, whether our study was not aimed to analyze the collaborative working behaviors, during the observation and interviews, some students had some concerns about the freeloaders while working collaboratively in the experimentation process and while writing the reports. This style of working while writing the reports was still a contradictory idea for evaluating the individual performance of the students. For assessing the reports, Pogacnic and Cigic (2006) proposed to finish the reports after the experimentation by not allowing the communication between students because 75% of their participants indicated that they could copy the report from their peers. Therefore, for the reports, extra time could be given to interpret the ideas, because the time for writing the reports could be short to analyze the experiments. In addition, the questions in the reports could be designed to engage students into the critical thinking process, and these reports could be provided through the resources, especially through the simulations. Each student could also follow his/her process in the experimentation.

5.2.1.2.4 External Issues

In addition to these problems, *frequency of the laboratory courses* and the *non-parallelism between the laboratory course and main lecture* also brought some problems in the environment. The laboratory courses in two weeks sequence made students not to fully engage and remember the course and non-parallelism resulted in discrepancy between the theoretical knowledge and procedural knowledge. Students easily forgot the course and the content knowledge. Therefore, it seemed unrealistic to expect the students to use the OERs behind these problems in the environment. Sending information about the OERs increased the students preparation time and use of them which also seemed to be a reminder for the course itself. In addition, the teaching process seemed to be poor to connect the theoretical and procedural knowledge, which could be supported by the content in the resources. It is obvious that especially for the experimental courses; students primarily seek to have some connections between the content knowledge and the future experiences.

Summary of this Section

- The teaching method and teaching styles was found to have a negative effect on preparations for the course and also use of the OERs because the students had not an active role on planning, and analyzing the experiments but only following the instructions from laboratory book or teaching assistants. The lack of preparation also observed the in the interaction between the students and teaching assistants. While the different teaching styles and long procedure of teaching process were mentioned as a problem, the integration of OERs could provide more standardized and attractive teaching process.
- As the teaching method and lack of interest of students leaded to more result-oriented experience, the lack of pre-lab exercises could also influence their learning experiences, which OERs could help to create more meaningful pre-lab exercises. While OERs had a positive effect on students' focus on experimental procedure, they still had some drawbacks for supporting content knowledge. Related with this the role of teaching assistants was also found related with the lack of preparation for the course and quality of questions asked by the students. While each course section was crowded which creates some problems for TAs to interest for each student, OERs could minimize the reliance on TAs while following the procedure.
- The assessment process which OERs had motly affected by its practices, this process was important to use and integreation of OERs into the system. While the scope of the questions negatively influenced the use of OERs and increased the reliance on laboratory book, the lack of post-assessment especially affected the interaction between the students and TAs and students' performance on experimentation process. Also the quality of the questions revealed the problems of laboratory book. While the validity of the assessments (especially reports) was mentioned, OERs could provide a platform to enable individual assessments.

- The frequency of the course was mainly criticized as alienating students for a sustainable course process; this problem was also mentioned as a barrier to use OERs as forgetting to use the resources and also preparation. In addition, the sequence of main lecture and laboratory course was defined as a negative issue to connect the lab with the theoretical information. The regular information for OERs also observed a reminder for the course, which also mentioned in the policy practices.

5.2.1.3 RQ1c. How do policy practices promote the use and integration of the OERs into the science laboratory environment?

5.2.1.3.1 OER Culture

GCLC system was operated in the same structure for many years with some benefits and drawbacks in the chemistry department. In order to understand the policy practices on department and institution base, it was essential to define faculty's (professors and teaching assistants) and students' personal activities and perceptions about open educational resources, which could shape their attitudes towards the OERs in GCLC system. Two main categories emerged in the study; user culture and academic culture, which mainly pinpointed the participants' activities and perceptions towards OER.

From the *user culture* perspective, most of the students and teaching assistants were aware of many kinds of open educational resources and their main source for these resources were university websites (OCW websites in general) and personal websites. They also used YouTube channels and iTunes U platform to discover some learning materials. As defining the selection criteria of the resources; popularity, reliable source of information and quality/scope of the content were prominent factors. Consistent finding with this study, Feldman-Maggor, Rom and Tuvi-Arad (2016) stated that most effective criteria for learners to prefer OER was found reliability of the website (e.g. institutions or related company's lectures). Thus, especially the resources provided by the universities were valued as more reliable content. Correspondingly, the courses they needed to find a resource was the courses which they had difficulties like calculus, physic or organic chemistry.

However, regarding the *awareness of METU OCW website*, the number decreased to only eight students and three teaching assistants. These participants were aware of the website before the chemistry laboratory course began. When the participants learnt the OERs was part of the website, which included many other resources from different departments, most of them did not explore the website. Some reasons emerged to prevent students from using the website were the lack of awareness, lack of interest through the courses, insufficient content provided in the website, and traditional learning activities. Insufficient information provided by both institution and department and the insufficient content were determined the drawbacks from the organizational side, the lack of interest, prejudices and traditional learning styles were defined the deficiencies from the learners' side. This study revealed that the barriers to METU OCW website was consistent with the results of barriers to use the OERs in terms of lack of information and interest. In consistent with the study of Muganda, Samzugi and Mallinson (2016), the major barriers to use of OERs were lack of encouragement by institution, lack of awareness and difficult to access and also lack of time and awareness (Phalachandra & Abeywardena, 2016). In addition, this finding was also important to show that some students still had traditional studying style to pass the course and the quality and diversity of the content/courses and popularity were important factors to use the OERs. According to the study of Farrow et al. (2015), they concluded that while the awareness OERs are increasing, there are still many initiatives remained unexplored beside some popular platforms like YouTube and Khan Academy.

From the *academic culture* perspective, professors were generally aware of the online resources, which they benefitted for preparing their course materials but there still a tradition to use traditional books and resources for the content knowledge. Some of them also mentioned to use some OERs for personal development but the use of them through the course environment were seem to remain only for preparing exams and using visuals. However, some of them also used some university's resources to learn some content knowledge. In here, it is important to note that none of the participants from the teaching side (professors and teaching assistants) were familiar with the opportunities of open educational resources and creative commons license. Only two of them were aware but they did not use the license actively. Correspondingly, their *sharing culture* also gave some insight for the lack of idea for openness. They had some concerns to share their resources, which were mainly originated from their lack of information about the references, personal concerns, academic concerns, lack of time and their concerns about the need of the resources. In consistent with the study of Kursun (2011), the professors indicated similar signs of supporting sharing culture but not participating actively. It is also significant to note that the ownership of the information and reliability issues were still important issues for people especially in academic environment (Kursun, 2011), which was also found in this study. Significantly, another concern emerged in this study that some professors were not eager to share the resources because sufficient resource was valid in the online platforms. Therefore, these attitudes showed that sharing culture negatively influence to develop METU OCW website, which could decrease the awareness and popularity of the website among students.

5.2.1.3.2 Department Support

Chemistry department was mainly criticized by the participants not to provide enough support for the resources through four issues; personal, system-related, resource-related, and organizational.

Personal issues: Academic achievements and rewards were seemed to be important criterion for professors for teaching a course. If the course does not provide academic opportunities, they might not be eager to fully support the course. For the second issue, the professors in the department were criticized for being inactive to use new practices and developments in their course, which decreased their motivation to use or support the OERs through the course. Hofstein and Lunetta (2004) criticized the science teachers’ adaptability for new educational developments and learning models were not satisfactory who still chooses to use traditional methods in their classrooms. Even if the participants (professors) declared to use different online resources through their courses, the support for the resources remained insufficient.

System-related issues: Similar with the academic concerns, system related issues also gave some clues about the support for the OERs. Attitude to general chemistry course was defined as the essential problem from both students and teachers’ side. The course did not hold any academic value for some professors and teaching assistants so that they did not choose to spare their time for service courses. In consistent with the literature, one of the challenges in the laboratory courses was the unwillingness of faculty or department to devote times to change, develop or reorganize the laboratory curriculum and activities (Bruck & Towns, 2013). Therefore, they might not develop or improve the resources in the system. In addition, teaching tradition in the course brought some problems for the interaction between the students and professors. Rollnick et al. (2001) stated that the laboratory was mostly viewed as a distinct component of the lecture courses, which hinder the connection between the theoretical knowledge and practical work. This distinction was also alienated the professors from the laboratory environment and decreased the connection in this relationship. In addition to this problem, even if teaching assistants managed the laboratory course, most of the students defined the owner of the course as professors so that this idea shaped some of their behaviors through the course. Professors had more influence on students than the teaching assistants, which were mentioned in many areas in the research. Therefore, even if the professors were aware of the OERs, the lack of communication and their role on laboratory environment mainly resulted in the lack of advertisement and encouragement for the resources. From the teaching assistants’ perspective, the situation was the same that they did not properly encourage the students for the use of resources. They were mostly dealing with the activities and practices in the environment rather than the learning practices of the students as distinct from the desired teacher role for effective instruction (Herrington & Nakhleh, 2003).

Resource-related issues: Some characteristics of the OERs prevent the professors to encourage for the use of the OERs. While some professors had some concerns about the quality of the resources, they did not attempt to analyze the possible effects of the resources on students' performance. One of the biggest challenges of using OERs was defined the lack of information about the effects of OERs and the lack of visual and virtual resources (Phalachandra & Abeywardena, 2016), this result is important to display the support for the OERs. Moreover, this situation could be related with the pre-selected resources like textbooks, which could lead the autonomy in the system (Richter & Ehlers, 2010). In addition, adoption was interestingly seemed important from some angle that some faculty wanted to actively participate the resources' development and improvement process to encourage them properly. Moreover, it was also interesting that the professors mainly mentioned to advertise the resources in their courses, the students and teaching assistants were not agreed with their statement.

Organizational issues: The lack of sustainable practices and decision-making process were featured problems in the system, which displayed the weak support and encouragement for the OERs mentioned in the literature (Richter & Ehlers, 2010). A disconnection was defined between the faculty and new practices in GCLC system, which caused a breakpoint to accommodate the innovative and changing environment in the system. Moreover, the lack of agreed policy for the OERs brought some problems to improve and develop the resources (McKerlich, Ives & McGreal, 2013; Mulder, 2013). In addition to that the GCLC system also suffered for the lack of communication for the activities and information to the students. The lack of communication also made students to ignore the e-mails sent from the department. At last, the department was also dealing with financial problems in order to renew the laboratory environment and equipment, which inhibit the practices related with integration of the OERs into course environment (Richter & Ehlers, 2010).

5.2.1.3.3 Desired Practices/ Strategies

Regarding the problems in GCLC system, the participants offered some desired strategies/practices.

System-related practices: The attitude towards the course was one of the major problems and to eliminate this problem some strategies were featured in terms of increasing the communication with students, designing the experiments regarding the interest and profession of the departments and offering general chemistry laboratory only for some related departments (chemistry engineering or molecular biology and genetics). However general chemistry course is an elementary course for non-majors, this recommendation could be not be meaningful to apply rather design of discipline-based laboratories seemed more applicable and reasonable. In addition, some faculty suggested increasing the communication with students by getting some feedback from their laboratory experience, and associating the content knowledge from the main lecture and experimental experience from laboratory course. In addition, some interaction channels were suggested to increase the communication while preparing for the course.

Resource-related practices: Some suggestions were provided to improve advertising and encouraging activities. While for advertisement; e-mails, recall by faculty and presentation during the class were featured factors; for encouragement, peer encouragement, bonus point, popularity and mobile platforms were emerged as preferred factors. Related with the encouragement issues, the optional use of the resources made the students feel more comfortable in the environment. The students mentioned that they should select to use the resources if they needed them. While the resources were seemed supplementary resources in this case as many other studies but the integration of them into the course system was also supported. While the obligatory practices to make students to use the resources were not generally advocated, the beneficial parts of the OERs could be integrated into the system especially for teaching and assessment processes. This integration could provide more meaningful and attractive learning and teaching process.

Organizational practices: For sustainable practices for the course and the OERs, a coordinator and working groups was suggested. Hofstein and Lunetta (2004) proposed that the teachers should be supported in their professional development by informing new technological or pedagogical developments. A coordinator could be assigned to inform new practices and to handle the communication with the students. In addition, the improvements for the resources could be handled by a group of people to attain the sustainability. In consistent with this result, Kursun (2011) mentioned importance of a dedicated unit for preserving the sustainability of the practices in the environment. In addition, an interdisciplinary approach could be managed to improve the resources and policy practices.

Institutional practices: As an institutional practice, it was important to generalize sharing culture (UNESCO, 2011). Precisely, the institutions played a vital role in these practices, which could provide benefits for both students/learners and institutions. Correspondingly, mentioned in the selection criteria of OER, popularity and quality of the resources were mentioned as essential characteristics so that providing the resources through METU website could bring opportunities for their own students and other students in Turkey who lacks the Turkish resources and contents. However, providing Turkish resources were defined as a rising trend (Kursun, 2011), most of the students complained to have insufficient Turkish online resources for their courses. This study also showed that while the students used the most known and popular university's resources, their own university or professors' resources would be the first choice to understand and study on their courses. For the institution base, providing the resources through some platforms also could bring some popularity in academic environment. As the institutional benefits of OERs were defined as the improvement on public image, engagement, usage (86% students and 73% faculty members use), sharing culture (90% of faculty members shared resources) and awareness of OERs at MIT OCW case (Hodgkinson-Williams, 2010). If METU provided the resources within wider and qualified resources, it could be the leader for the practices in Turkey. In addition, for a university, it is essential to increase the awareness of the current resources and promote to develop the OERs in new digitalized environment (Muganda, Samzugi & Mallinson, 2016). Similarly, this approach defined as vital by most of the participants, which showed their need for different resources for different courses. However, in here, it is important to emphasize the scope of the content as internationally, which could help other learners from different area. Because of the content in the resources were mainly associated with the content knowledge in the main lecture, and the scope of the content were mainly focused on the experimental procedure, these resources could be meaningless for other students from different universities. Thus, sharing the resources should be fully concentrated on the scope, quality and length of the content to provide them universally.

Summary of this Section

- Awareness about OER from different sources was high which could gave a clue about the students, TAs and professors' perceptions about the OERs in GCLC system. It is important that while all the TAs and professors used open educational resources from different channels, the support for the OERs in this case was low than expected. This could display that the OERs had not been embraced in the course system properly. While the selection criteria of these resources could provide an insight of the institutional practices for the developments of OERs, the awareness about METU OCW pointed some major problems for the future of OERs at the institution. Related with this issue, academic culture related with OERs could also provide an insight for the future developments and improvements of OERs in chemistry department.
- From the department side, while the personal issues emphasized the academic developments and new technological adaptations, these concerns could be eliminated by some institutional practices to support professors for academic development.

- System-related problems referred to attitude to general chemistry course, which was also significantly found from students' side, and the devoted time of professors for laboratory courses. These two problems could also prevent faculty members to improve the course and particularly the OERs and advertise/encourage the OERs.
- The quality of the OERs was found as an important factor for both using the OERs and encouragement practices that poor quality of the OERs could inhibit the encouragement of using them.
- Some organizational problems also seemed to alienate the professors from the new practices in the laboratory course. No agreed policy about the sustainable use of the OERs, the lack of sustainable progress between the course periods, the difficulty on decision-making process and financial problems also prevented to find out practices for the use and integration of OERs

5.2.2 RQ2. How do the utilization of resources facilitate the students and research assistants' perceived performances through the laboratory course?

5.2.2.1 Expectations about the Course

The students and teachers expectations and aims of a course are important factors to determine their teaching and learning activities, activities in the laboratories (Galloway & Bretz, 2015; Pyatt & Sims, 2012). According to the review of Reid and Shah (2007)'s study, students required to have obscure purpose of laboratory work, which significantly affect their attitudes towards laboratory classes negatively within the lack of these purposes. In this study, the purposes were diverse which was categorized as cognitive, psychomotor and affective. Between these purposes, the affective one was the most mentioned category by the students, while the professors focused the cognitive one. As consistent with DeKorver and Towns (2015) study, the most stated goals were finishing the experiment earlier, getting the correct results, learning laboratory techniques and skills so that while the students were described their goals through affective and psychomotor domain, faculty goals were more focused on as cognitive and psychomotor domains.

The discrepancy between the students and teachers' aims were emerged that while the students expectations were driven by some extrinsic motivators and some intrinsic motivators by low-level cognitive skills; teachers expectations were mainly emphasized the high-level cognitive skills by interpretation and analysis of the activities and content knowledge. Only few students mentioned their purpose driven by high-level cognitive skills. Therefore, students wanted to get higher grades, to spare good time while learning some practical skills and to learn some procedural knowledge related with the experiments and experimental procedures in the environment. Misalignment between the students and faculty goals' was mentioned to have a negative influence on laboratory experience, which could direct the students to focus on affective outcomes of performance (getting high grades, finishing earlier) (DeKorver & Towns, 2016). Similarly, in the study of Galloway and Bretz (2016), most of the participants performed to get correct results of the experiment; they mainly ignored the theoretical principles of the experiments. In here, another critical point was the different perspectives of the professors and teaching assistants that while some of them associated the problem with the students learning behaviors, some criticized themselves for not providing a satisfactory teaching to engage the students into the process. When the teachers' expectations, activities and assessment technics were also determinants of the students' attitudes (Hofstein & Lunetta, 2004), the faculty missed the significance of affective and psychomotor side of the learning experience.

At last, it was also significant that the students' expectations for the course indicated similar results for the motivators to use the resources. Especially for the extrinsic motivators, the students seemed to seek some ways to fulfill their aims for the course in terms of finishing the experiment earlier, getting higher grades and to have information about the experiment. Therefore, how the resources fulfill their aims and the outcomes of using the resources were discussed through four sections below.
Even if the students' expectations from the course were especially connected with

getting higher grades and while the OERs lack of correspondence with the content in the assessment was explicit, this problem did not seem to affect the user profile as expected, other major problems were raised as lack of interest and lack of information about OERs than the possible grade effect.

Summary of this Section

- The expectations about the course also pointed similar expectations from OERs. While the affective expectations seemed prominent for students, cognitive and psychomotor expectations were important for faculty members
- The expectations also gave some clue about the performance outcomes that OERs failed to address especially the academic performance and cognitive domain.

5.2.2.2 Effect on Academic Performance

As seen in the performance outcomes part, while most of the students mentioned to get satisfactory grades to pass the course, other three important outcomes for meaningful learning were seemed to be unsatisfactory. For the academic performances, the OERs were mainly criticized the obscure effect on the grades of the students because of many external factors. The results showed no significant difference on students' grades like Hill and Nelson (2011), Dupagne, Millette and Grinfender (2009) and Powell and Mason (2012) study related with video podcasts. Similarly in their study, (Jolley et al., 2016) found that pre-lab quizzes and videos facilitated the users' psychomotor and affective experiences but not significant increase in academic performance (grades). The reason of this result in this study could be twofold. First, there was not a mechanism to evaluate the students' performance in the experimentation process (except teaching assistants' personal evaluations); the quizzes and reports were mainly directed by the questions from theoretical knowledge and safety issues mainly mentioned by laboratory book (see assessment process). Thus, these results could not be reliable to define the resources as effective or not for the students learning activities. However, it could be mentioned that the resources did not indicate negative experience for students. In addition, some students believed that the resources increased their grades because they had meaningful experience on answering the questions in the assessment part. Second, some external factors were defined essential for academic performance in terms of background of the students, interest for the course and success on university exam. Even if less-biased groups were selected based on their university exam score and performance in GCLC, different group of students benefitted differently with these resources. For example, the mechanical and computer engineering groups were defined with higher studying responsibility groups but they were also mentioned less interested groups in chemistry laboratories, so that the interest for the course is not sole factor to determine the performance of the students. In addition, the quality of laboratory book could affect the grades of the students who used only the laboratory book. The lack of understanding for a concept and descriptions in the written resources could lead the students to rote learning that the students could achieve better scores by memorizing the concepts in many areas (Mintzes, Wandersee & Novak, 2005). Some participants mentioned the problems on understanding the experiments in laboratory book, which routed them to find alternative ways to pass the course. Therefore, the explicit clues about the quizzes in the laboratory book could make students to have higher grades by memorizing the concepts in the book.

Summary of this Section

- While some students used the OERs for getting higher grades expectations, most of the students criticized the OERs did not have a dramatic effect on their academic performance
- The scope of the content in the quizzes and reports was determinant for the OERs effect on grades of students
- As the students' expectations was mainly originated by academic concerns, the integration of the resources to the assessment process seemed critical for the use of OERs.

5.2.2.3 Effect on Cognitive Outcome

For a meaningful learning experience, three domains (cognitive, affective and psychomotor) should be satisfied (Galloway & Bretz, 2015). Regarding the cognitive outcomes, two low-level cognitive skills were revealed; knowledge and comprehension.

For the *knowledge* part which comprises factual-conceptual and procedural types; the main focus of the OERs were supporting *procedural knowledge* in the experimentation process rather that the *factual-conceptual knowledge*. Students only mentioned the OERs to help to identify the chemicals and equipment and their characteristic related with the *factual-conceptual knowledge*. As one of the barriers to learning chemistry was defined as using unfamiliar materials (Gabel, 1999), the OERs helped to identify the chemicals and materials before each experiment. The second effect was defined to possibly prepare the students' mind to focus on the conceptual knowledge rather than the procedural knowledge. However, the students were still observed to be stuck on the procedural knowledge in the course environment. Domin (1999) criticized the expository laboratory to mainly support the lower-order cognitive skills, which comprise knowledge, and comprehension levels. Similar with this inference, neither the OERs nor the process of the laboratory referred (teaching method and leaning experience) to the higher order thinking skills. The answer of this problem could be dichotomous; the process in the OERs leaded the students to memorize the process (possibly forgot some parts) rather than the interpretation; or the students' concern to get correct results of the experiments were still higher than expected. Thus, this study showed that, even if the students see the process in advance, they still have some problems during the experimentation process as mentioned in the adoption-implementation part.

For the *procedural knowledge*, the OERs, especially videos had positive effects to visualize the process, to remember the steps in the experiments and to see how to conduct the experiments with required equipment. In their study, Nadelson et al.

(2014) described the videos as powerful tools, which showed the actual representation of the experimental procedure and also helped to support the instruction provided by the different information channels (instructional materials and instructors). Correspondingly, Jordan et al. (2016) concluded that the students with video instruction recall the procedure better than the students who did not (23% of increased recall) and increase the understanding of the experiment. In addition, according to the study of Long, Logan and Waugh (2016), videos for pre-laboratory instruction were found to facilitate the students' understanding and the students had positive attitudes towards videos. However, in this study, simulations were defined as not successful as videos that they only help to memorize the steps of the process and to see some key points in the process which in line with the study of Hill and Nelson (2011) that the visual images helped to memorize the facts. Multimedia and computer-based learning could be effective when the users' pre-knowledge and aptitude was low because of the lack of current cognitive models (Najjar, 1996), this inference could be discussed in line with the perceived cognitive outcomes of this study. The level of complexity of the experiments and the level of experience were found as effective factors to use of OERs, most of the students and teaching assistants were new at this experimentation so that OERs could promote to built cognitive models.

Regarding the *comprehension* part, only small part of the students described their experiences more meaningful and open to interpretation for understanding the experiments. Most of the students portrayed their activities based on memorization rather than interpretation, which was also supported by the teaching traditions in the course and the quality of the resources. None of them leaded the students to interpret their activities in a meaningful way. In addition, the OERs did not provide different knowledge for students rather than the laboratory book and the information from teaching assistants. Moreover, the educational system was also criticized to support getting higher grades rather than providing critical thinking for students. Thus, this study revealed that it is important how to provide the information with media. Even if the resources provide some knowledge for users, it remained insufficient to support higher order thinking skills for the students.

Summary of this Section

- In line with the expectations from the course, OERs mainly referred to low-level cognitive skills as knowledge. The OERs and the learning and teaching activities in the course were mainly criticized as the lack of interpretation which provide a contradictory profile with the faculty members' expectations for the course
- The significant effect of OERs on cognitive domain was described by procedural knowledge, which enables users to remember and understand the process of experimentation especially for novice learners to see how to apply a procedure

5.2.2.4 Effect on Psychomotor Skills and Activities

For the second category for meaningful learning, psychomotor skills and activities, ability to use the equipment and offering safety instructions in some critical parts of the experiments were featured headings in this study. The visual and interactive resources had an effect on students' ability to use the equipment and materials in the experiments in consistent with the studies of animations effects' on procedural skills (Arguel & Jamet, 2009; Ayres, Marcus, Chan & Qian, 2009). Moreover, memorizing the experimental procedure and ability to use the equipment also helped the students to finish the experiment earlier, which made them to share more time for writing the reports. The students who used the OERs as pre-laboratory preparation showed better performances on completing the experimental process than their previous performances. This result is consistent with Nadelson et.al. (2014)'s study, which represented that the use of videos as pre-lab resources made positively significant change in time to perform the experiment. However, the students mostly wanted to finish the experiment to get free instead of sharing more time for reports. So that the early finishers could be directed for some tasks to enhance their critical thinking skills.

Summary of this Section

- OERs helped to recognize the equipment and chemicals within how to use them during the process of experimentation
- OERs also enable users to finish the experiments earlier, which could also associated with their ability to remember the process easier.

5.2.2.5 Effect on Affective Outcome

For the last part of meaningful learning, affective outcomes, three issues were emerged in the attitudes towards the resources in terms of quality of the resources, benefits of the resources and necessity of the resources.

Quality of the instructional resources: Three instructional materials used in this course as laboratory book (compulsory), OERs (videos and simulations/optional). *Videos* were defined as successful in some technical details by their visual quality, length and teaching process. However, teaching process was defined as satisfactory for procedural knowledge but deficient for enhancing the critical thinking and content knowledge. They mostly offered to integrate some key knowledge, which combines the procedure with the content knowledge. However, participants criticized *simulations* (virtual laboratory) through many negative perceptions contrary to videos. While some participants found the environment as attractive and enjoyable, quality of visuals, teaching process and technical problems mainly affected the users' attitudes and behaviors toward virtual laboratories. While simulations provide some opportunities to visualize the abstract concepts and phenomena in laboratory (Pyatt & Sims, 2012), as contrary to the literature, most of the participants were not fond of the simulation environment and the environment was not preferred as a replacement for the traditional laboratories. Especially, the technical problems seemed to make distant the participants from the environment. Velazquez-Marcano, Williamson, Ashkenazi, Tasker and Williamson (2004) mentioned that video demonstrations and animations were not effective alone but they provided meaningful student performance when used together. However, in this study, most of the participants preferred the videos over virtual laboratories for these experiments which the videos were defined as the most effective medium for skill-based lab sessions (Tsekleves, Aggoun & Cosmas, 2013) and the videos were defined the most preferred form of OER (Hu et al., 2015). Moreover, the preference of the videos could be derived from the quality of the virtual environment and the complexity of the experiments because participants mentioned to have virtual labs for more advanced chemistry courses (e.g. organic chemistry). In addition, two resources could be extraneous for these kinds of experiments in the level of complexity. The second explanation for the preference could be explained by the feeling of *presence* in the environment. Sauter, Uttal, Rapp, Downing and Jona (2013) highlighted the importance of "authenticity" and "reality" sense in the simulations and videos, which could increase the engagement of the users with the activities. In addition, in their study, the participants described the videos provided more authentic environment than the simulations did. Consistently, in our study most of the participants preferred the videos, which showed the actual setting of the experiments than simulations because simulations were defined not to have appropriate visual quality and applications for the university level of students by most of the users. This could also be associated with the 2D nature of simulations that provided less meaningful or authentic context than 3D environments (Dalgarno, Bishop & Bedgood Jr., 2003). Also in the simulation, the users could be much possibly focused on how to truly apply the process rather than focusing on the details in the process which could direct the students to use videos rather than simulations.

Related with another instructional material in the course, *laboratory book*, most of the students preferred to use the laboratory book with the OERs. Even if the laboratory book had many criticisms by the participants in terms of complexity in the conceptual knowledge, language and lack of visuals, most of the participants saw the laboratory book as primary material for the course. This preference could be derived from the optional use of the OERs and the connection of the laboratory book with the components of the system. However, in the literature, many research studies indicated the students' attitude towards textbooks was negative in terms of learning and they did not spare time to read (Berry et al., 2011). In consistent, neither the students nor the research assistants were satisfied to read the laboratory book, which they mostly had problems to understand. As also mentioned in the preparation part, they mostly interested in the theoretical part to determine the possible questions in the quizzes. Therefore, integration of the OERs into the system did not change the place of the laboratory book but revealed and raised the criticism about the quality of the laboratory book. Regarding the criticisms about laboratory book was to preserve too much information in a complicated way. Domin (2007) mentioned that the quality of the laboratory manual could direct the students' filtration of important information that the laboratory manual could not be designed to preserve too much information for students. In line with this problem, Reid and Shah (2007) evaluated the laboratory manuals and they concluded that they should be redesigned to reduce the cognitive overload by providing key information for students. Therefore, students had some challenges to understand and extract the important information from laboratory book, which could indicate that the OERs' could provide more understandable way for procedural skills. However, students' choices of material type also pointed why students still preferred to use laboratory book. The perceptions related with the online and printed materials, this study showed that some participants still depended on the printed materials, which made them feel more comfortable while studying. However, the rest mentioned to prefer online materials for reducing cost and providing ergonomic environment.

Benefits of OERs: This study indicated that the OERs had some benefits in consistent with the studies in the literature that the users (both students and teaching assistants) had comfortable experimentation process which helped them to be more relieved and self-confident. Related with this finding, the study of Jordan et al. (2016) showed consistent results that student who used video as pre-laboratory preparation indicated more self-independent performance and less reliance on TAs. Moreover, other affective outcomes were also consistent with the studies in the literature in terms of**,** familiarization of the environment, which could mitigate the anxiety and lack of confidence (virtual laboratories) (Dalgarno et al., 2009), increase the preparation time and quality (pre-lab quizzes and videos) (Jolley et al., 2016), providing different learning experiences, and providing language choices. Regarding the language opportunity, Danili and Reid (2004) outlined the factors, which might affect the difficulty in learning chemistry in terms of complexity of the subject, language (especially in second language learning of chemistry) and sequence in the curriculum. In here, especially the language could create difficulty for learners to grasp the meaning of the experiment (Rollnick et al., 2001). Moreover, from the teaching assistants' experiences, the OERs helped them to reflect on their teaching methods and to get some ideas or inspiration for teaching the abstract concepts and details in the procedure. In consistent with this finding, OERs' effect on teachers' teaching practices were defined meeting different learners' needs, expanding the teaching method, and reflecting on their teaching methods (de los Arcos, Farrow & McAndrew, 2016). In addition to that, based on the teaching assistants' observations and perceived students' performance, they were aware that the OERs could help the students to understand the content by visualization, feel more comfortable and self-reliant, apply the procedure correctly and set up the experiments, and to recognize chemicals and equipment.

Necessity of OERs: Beside the positive experiences, some participants did not have satisfactory learning experience with the OERs and they were not sure about the necessity of the resources. The OERs did not provide different learning experience than the usual and they did not provide any benefit for the learning process (lack of critical thinking, minimal effect on grades and understanding the experiment). Correspondingly, based on the quantitative results, nearly half of the students who were aware of the OERs did not use them because the laboratory book was enough to complete the course as satisfactory. However, most of the participants thought that the resources were not irreplaceable but they provided more comfortable and satisfactory learning experience for them within the developments of the OERs for better experiences. In the literature, virtual laboratory defined to be both alternative and supplementary for the traditional hands-on labs. Darrah, Humbert, Finstein, Simon and

Hopkins (2014**)** concluded their study in consistent with the literature that their virtual physic lab did not differ from the traditional lab based on learning outcomes. Similarly, Pyatt and Sims (2012) concluded from their study that both hands-on labs and virtual labs had satisfactory results for students. Therefore, virtual lab experience could serve an alternative way for the traditional laboratories. However, in our study, virtual laboratory environment were defined insufficient to provide a whole laboratory experiment instead of the hands-on laboratory in consistent with the Farrow et al. (2015) and Hu et al. (2015) study which the participants used the open educational resources as supplementary. Specifically, videos were determined as more satisfactory tools for the experimental procedures but they also mostly defined as supplementary tools for the hands-on labs. While different media provides different learning opportunities (Castro-Alonso, Ayres & Paas), this study did not indicated that the videos were better than simulations rather the videos were more successful to meet the needs of the users in this case.

Therefore, this study showed that the OERs met the expectations for the course in some domains especially for the affective part but for a meaningful experience, all three domains should be fulfilled in the laboratory environment (Galloway & Bretz, 2015). The simulations had positive affects on especially cognitive and affective domains (Rutten, van Joolingen & van der Veen, 2012). However, the expectations and goals of students were valid in each domain, the connections between these domains are missing that students mostly failed to combine each domain while doing the experiment (DeKorver & Towns, 2015). This study showed that while the students' expectations might vary from different purposes for the course, there is still a need to support their cognitive and affective experiences in relation with each other in laboratories. Jolley et al. (2016) concluded from their study than the pre-lab quizzes and videos improved students' psychomotor and affective experiences. In consistent especially affective and psychomotor parts was seemed to be mostly affected but the resources had somewhat minimal effects on cognitive outcomes.

Summary of this Section

- Quality of the instructional materials played a significant role on both using the OERs and policy practices. The videos were defined as more satisfactory for these experiments rather than simulations, which comprise some technical problems, visual characteristics and presence perceptions.
- Laboratory book was criticized by many points of difficulty of language, lack of visuals and long procedure to learn, the students mostly preferred to use that with OERs. While the book seemed as a primary material for the course because of the system process, the preference for printed materials could also indicate this usage behavior of laboratory book.
- As the users mainly mentioned many benefits related with the affective domain especially for more comfortable and self-reliant process in the course environment. While the characteristics of the OERs played a vital role for usage of them, this domain is also important to show the effects of the resources on both students and teaching assistants' affective domains.
- While most of the participants mentioned the benefits of OERs, some arguments about the necessity of them were also critical and valuable. The OERs did not provide significant changes for some participants on their performance. This inference did not lead to the argument about the necessity of the OERs which most of the students defined OERs as not essential and but beneficial but it leaded the position of OERs as supplementary not an alternative for laboratory courses.

5.3 CONCLUSION AND RECOMMENDATIONS

5.3.1 Recommendations for Institution

In the systemic environment, institution had a major role on some policy practices about METU OCW and support for new developments and practices related with the OERs in this case. Some policy practices were defined to have some direct or indirect relationship with the OERs in this case. Therefore, some suggestions were offered about how to minimize the problems related with the policy practices through institution base.

5.3.1.1 Awareness of METU OCW

Awareness about the METU OCW website was specifically found very low than expected. This issue also found one of the major barriers of low usage of the resources in METU OCW website. Some recommendations were provided to increase the awareness of resources as:

- Even if the advertisement of OCW was seen on university website, it seemed to be ignored by students. Especially new registered students could be informed during the orientation sessions, brochures or booklets. E-mails was also found effective to inform the users about new practices which could be sent to inform the new courses or resources added to the website.
- OCW website could be used in cooperation with ODTU Class which was a learning management system (LMS) used through the institution. Some links could be provided in the system which directed students to OCW website.
- An expert or a unit who have knowledge and experience about OER practices could be assigned to monitor or regulate the OCW and OER practices inside the institution.

5.3.1.2 Generalize Sharing Culture

For the resources in METU OCW website, the institution, departments, and faculty members have primary role to improve the platform. Some recommendations about how to increase the sharing culture provided below.

- Completion of the website by the content seemed important for some students, which was also found one of the major barriers to use OCW website. Some encouragement practices could be attained to increase the courses and resources in the website. Faculty members have critical role here to expand the resources. While sharing culture is still low in OCW website, some strategies could be developed for encouraging the faculty members (Kursun, 2011). At first, faculty members could be informed or trained about the OER creation, adoption and implementation practices. Workshops or training could be implemented to inform the faculty members. While METU provided Academic Development Program (AGEP) to improve new faculty members' educational, social and research abilities, this program could provide some programs related with how to support the faculty members who wish to create, design, find and integrate OERs in their formal courses.

- While the faculty members' lack of time to adopt new practices, the institution could consider some reward opportunities for faculty members to participate the sharing practices.
- Especially some courses gains more attention and need (physic and calculus) and some faculty members seemed to have popularity among students. These faculty members could be encouraged to provide their resources.
- Some communication channels were found popular among students; and their OER usage behaviors showed that they mainly found the resources based on the recommendations shared through these platforms (Facebook, Twitter, etc.). In addition, these kinds of resources were seen as bringing value and popularity for the university so that the university should share the resources in a qualified level.
- While the increasing trend for universities sharing their course materials through different platforms or through some organizational cooperation through their own OCW website, iTunes U, Coursera, Udemy etc., METU OCW has not still gained his popularity and awareness through these universities. The cooperation with these popular platforms, the resources could gain more attention and popularity among users.
- While most of the students are using the resources from different languages, it was found to have a significant demand for Turkish resources. This study

revealed that one of the reasons to use the OERs in GCLC was providing Turkish version of the content. In addition to that, many of the students mentioned to have their own faculty members' course resources so that it is important for the university to be a pioneer among Turkish universities.

- While a dedicated unit is responsible for OCW activities (ITS- Instructional Technology Support Office), the support of faculty members is still an essential factor to generalize sharing culture. When faculty members and university websites are important factors for the diffusion of innovations (Hu et. al., 2015), their cooperation could improve the use of these kinds of resources. Moreover, while there is a need and demand for online resources especially electronic (Power point slides, pdf files, animations) and videos (Tsekleves, Aggoun & Cosmas, 2013), increasing these diverse resources could be beneficial for formal and non-formal learners.

5.3.1.3 Quality of the OERs in GCLC System

Quality of the resources and some technical details found as an essential component for the students to use them and for the faculty members to support them (see encouragement). The recommendation about the quality could be considered as the mission of the institution and a dedicated unit for design and technical support for the resources (ITS unit at METU in this case). These recommendations could also be helpful for faculty members and teaching assistants who worked collaboratively with this unit while creating these kinds of resources.

- Videos generally defined as successful to visualize the experimental process except some technical details (lack of theoretical knowledge, update problems and language quality). However, the simulations were the most criticized resource in the course by teaching quality, visual quality and technical problems. For the teaching quality, the steps in the experiment and activities were too explicit to enhance the students' thinking process. The steps could be designed to enable users to decide what to do in the process. In addition, some explanations and some feedbacks could be provided in each step of the experiment.

- For the technical problems, some explanations about how to use the tools in each screen could be provided. For the visual quality, many different simulations and virtual laboratories, remote laboratories are valid (Phet, Virtual Laboratories etc.) and new developments in the visual world, the graphics could be optimized for undergraduate students' levels. Correspondingly, visual quality could also affect the reality and authenticity of the experiment. Regarding the authentic environment, Potkonjak et al. (2016) provided a guideline to design and evaluate the quality of virtual laboratories. In addition, Jelfs and Whitelock (2000) provided a metric to evaluate the presence in virtual environments in terms of audio changes, level of interactivity, feedback, ease of navigation, previous experience and persistence. Among these, in this study, feedback, level of interactivity and ease of navigation found critical which could correlate with the sense of authenticity. Therefore, these components could be taken into consideration while redesigning the simulations.
- Professional development or technical assistance program could be provided to help the faculty members on how to create, use and integrate the OERs into course systems.
- Mobile applications of the resources and the website as a whole could be provided as a usability opportunity and the current resources could be adapted to the mobile platforms. This approach could also facilitate the OERs integration and usage through the laboratory course during the experimentation process.
- Technological infrastructure and financial support was seemed crucial for practical courses with high demand of technical devices, equipment and safe environment in the laboratory. While the equipment, devices were observed as too old-fashioned, the financial support was needed to redesign the laboratory with new technological devices, equipment and objects in the environment.

The financial cuts were also found negatively affecting the integration of the OERs into the laboratory environment. Institutions could arrange the funds to digital devices (like tablets, computers or projectors) to enhance the technical quality of using the OERs.

5.3.2 Recommendations for Department

5.3.2.1 Awareness of the OERs in GCLC System & Advertisement

Awareness of the OERs in this case was not high before the laboratory course began. Some barriers revealed through this study about the awareness issue by students' side and faculty side. In order to increase the awareness of the resources, some recommendations were provided for faculty and department. The optional characteristic of the resources affected the user profiles of the resources; however, the frequency of using the resources with regular information was surprisingly high than expected. However, some suggestions could be followed to increase the use of the resources by using some advertisement and encouragement practices.

- Some advertising issues were emerged in this study but one of them is highly corresponded with the faculty members. Faculty members, who normally don't have direct relationship with the laboratory course in this case, were still seen as the leader of the GCLC system. Besides teaching assistants' calls for the resources, faculty members also have a critical role to increase the awareness about the resources. They could mention the resources verbally in their courses, they could send e-mails or they could actively show the resources in the course. While e-mails were found important contributors for advertising and encouraging using the resources in this study, they could use this strategy for their courses.
- E-mail was seen as an effective method to inform the students, and also to remind the course period. E-mails were also found effective to regulate the students' use of the OERs. Sending e-mails is an easy but a useful way to

increase the awareness of the students about the resources so that a coordinator (between faculty members or administrative personnel) could be assigned to regularly inform the students about the resources before each class by e-mails to remind the pre-laboratory activities and resources or other information related with the department

- Besides faculty members, department has also a critical role for advertising the resources which comprise e-mails, social media channels, website announcements and posters. In addition, social media platforms (Facebook groups or Twitter hashtag) could be used like e-mails, and groups could be generated through social media, which enable students, and assistants to communicate and share, the faculty member could also inform the students about the resources.
- Another strategy was mentioned to show the OERs at the beginning of each semester to increase the recognition. While the distributed brochures were found somewhat ineffective to attract the students' attention for the resources, online ways of advertisements could be more large scaled advertisement method.

5.3.2.2 Perceived Value of the Course

Some policy practices could be suggested to increase the perceived value of the course, which found to be affected by the students and faculty members in this case.

- General chemistry course as service course do not get enough value and interest from the students and faculty members. More personalized and departmental approach was recommended by some participants like personalizing the experiments for the departments to show what the information will work for their future academic life. This approach could impact the students' interest and perspective for the course if they see the advantages of the course for their profession. In order to practice this recommendation, interdisciplinary approach through different departments and faculty members could be used to create associated experiments for different disciplines. The department and faculty members could also have a decision-making process to analyze the experiments' role on students' profession. This process could also provide a renewed perspective for the department and could also decrease the burden on faculty members for time and energy to spend much time for the course.

- Some technological devices could also be used to increase the engagement of students to have more authentic learning experience. Beside OERs, 3D printers have been using to create a product, which could also be applied for students to create some models for Chemistry-related concepts.
- For faculty members, the department could use some strategies to academically encourage the faculty members to increase their engagement for this course. If faculty members and teaching assistants could show their engagement for this course, the students' perceptions could change for the course.
- As seen at the different institutions, faculty members could have a title either teaching or clinical professor. While teaching professors are generally dealing with the teaching practices, clinical professors are mostly studying on research. For GCLC system, teaching professors could be assigned which could minimize the academic development concerns so that teaching professors could provide more devoted time to improve the quality of the course.

5.3.2.3 Sustainability

Some recommendations could be offered to maintain the sustainable practices in the department for new developments like the OERs in this case.

- New technological developments, resources and methodologies for teaching practices within an in-service training could supervise the faculty members' adaptability for these practices.
- An agreed policy about how to develop, adopt and integrate the OERs into the course system should be prepared. CreativeCommons provide *OER Policy Registry* database, which shared the policy practices from different countries

and institutions. These policies could guide the practices in the department or an expert or a unit could be assigned to provide guidance for forming policy practices.

- Some dedicated units to catch up the new developments in the department could support them. In order to provide sustainability for the new developments (like resources), some informative units could transform the information for new faculty members.
- These informative units also support the communication between the students and faculty members for the resources. This informative approach could help the decision-making process in the department which mainly dealing the other major problems in the department.
- Some units by faculty members could be organized to deal with different problems in the department (for example problems in the laboratory, problems related with financial constraints, problems with the main lectures) so that this could minimize the decision process for the department.

5.3.3 Recommendations for Faculty members, Research Assistants, Teachers

5.3.3.1 Preparations for the Course

Students' preparation behaviors and activities are essential component of the system, which could determine their learning activities in the classroom. For the laboratory courses, which require the learners' ability to comprise their cognitive, psychomotor and affective experiences, somewhat the pre-laboratory preparation is essential to prepare the mind of the learner (Johnstone & Al-Shuaili, 2001).

In this study, the videos and simulations were found to be used as pre-lab resources, which also mainly used in several studies in the literature. However, the quality and the content of the resources are key factors to prepare the students for the course. The critical point for preparation was described by three factors as to familiarization of the environment (know the places of equipment), decision of which equipment or chemical to use and understanding of the theory combined with the experimentation (Dalgarno, Bishop & Bedgood Jr., 2003). Based on these three parts of preparation, OERs seemed to only fulfill the second part of the preparation.

- For the content of the OERs, besides only providing how to conduct the procedure of the experiment, some key knowledge could be provided which triggers how and why questions for the content knowledge. In their study, Berry et al. (2011) compared the students' responses for how to motivate them to read the manual and they concluded that the students search for key material rather than the amount of materials. Therefore, instead of giving apparent information, some key knowledge, which comprises important information about the content and procedural knowledge, could help the students' understanding and made the preparation process more qualified. For pre-lab exercises, students could be provided what to expect, what to do during the experiment and which equipment to use clearly (Johnstone, Watt & Zaman, 1998).
- The role of the teaching assistants and the teaching tradition in the course also defined to negatively affect students' preparation activities. The role of the teaching assistant should be reevaluated to be a guider for the students, which could also minimize the students' asking behaviors during the experimentation procedure. Even if the teaching process was aimed to standardize by department, TAs should be informed about how to behave in the course environment.
- The teaching tradition is important that the students preferred to study on theoretical knowledge rather than procedural knowledge. In here, the pre-lab activities could be designed to both focuses on each knowledge types. While the OERs helped the students to more focus on procedural knowledge, the essential part is to correspond them for more meaningful learning. In consistent with this behavior, the students tended to have quiz-directed preparation which also negatively supported by the quality of the laboratory book. Therefore, the

content in the laboratory book should be reviewed by elimination the extraneous and explicit information about the content.

5.3.3.2 Teaching Process

For the teaching practices, while the different strategies were proposed in the literature, the number of the students and time constraints challenged to implement these methods in this system. However, some key practices could be integrated into the process. Domin (2007) based on his study, which compares the problem-based and expository teaching styles, reflected that meaningful learning could be achieved by providing students an opportunity to think of their acts and behaviors in the laboratory. Therefore, within the clear purposes and necessary guidance, some activities could be integrated into the process to enable students' thinking activities. In here, the resources could be designed to help the teaching process in this case. In the literature, these types of resources were mainly used as for pre-lab activities or replacement for the laboratory process like virtual laboratories. In this study, the third strategy was emerged as the integration of the resources during the course process. Even if many concerns were defined as technological barriers, the role of the assistants and interaction between the students and teaching assistants, most of the students and teaching assistants mentioned to be happy if they had an interactive teaching process with the videos in the teaching process. This choice could be conceived by the challenges they faced when they were talking about the experimentation process verbally, they mentioned to be more comfortable to teach the process with visual resources. In addition, this concrete approach could improve the interaction between the students and teaching assistants, which eliminates the long procedure of the experiments. For an inquiry guided activity, several studies mentioned how to integrate simulations into laboratories (Moore, Herzog & Perkins, 2013; Moore, Chamberlain, Parson & Perkins, 2014), the main benefit of the simulations were defined to guide the instruction and simplify to see the results of the experimentation.

Therefore, in order to integrate the resources into the teaching process, three scenarios were recommended:

- For the first scenario, the video and simulations are used as pre-lab activities that students are expected to learn the content and procedural knowledge within the resources like flipped-classroom approach. Some knowledge about the theoretical part before the experiment (beside the theoretical part in the laboratory book) could be added into the resources or some content videos could be created for the content knowledge of the experiment (content videos are mainly used form of instructional videos that contains the instructors' teaching process of the content in the classroom or any other environment), which could also minimize the time for the theoretical part in the classroom. However, the length of these content videos is also a crucial issue to consider so that the content could be divided into different videos (approx. 10 min). In the classroom, instead of teaching process held by teaching assistants (approx. 15 min), students and teaching assistants could discuss what to learn and infer from the experiment before conduction the experiment. Prior knowledge is defined as an important component for content knowledge and some key knowledge could be provided during the instruction time (e.g. during the simulation) rather than before the instruction time which could increase the students' experimentation abilities and practices (de Jong & van Joolingen, 1998). Thus, in this scenario, it is also important to provide the key knowledge during the discussion process also. If the instructional method is determined as inquiry-based, the simulations could provide valuable experience. In inquiry-based laboratories, simulations could be used before the laboratory class within interactive features inside (questions that guide the observation process, feedbacks, or quizzes)
- For the second scenario, beside some pre-lab activities, videos could be used during the teaching process, which was also supported by some participants in this study. Feldman-Maggor, Rom and Tuvi-Arad (2016) mentioned that

videos are popular to use them to demonstrate the experimental procedure during the class so that teaching assistants could use the videos to explain experimental procedure by combining them with conceptual knowledge. This scenario could be more helpful than explaining the procedure in blackboard. During this period, the interaction between the students and teaching assistants is also essential that the students should be triggered to participate the discussion process. In order to increase the students' engagement, some pop-up quizzes could be used during the teaching process through some quiz programs or clickers.

- For the third scenario, while the simulations could be used as pre-lab activity and within in-class activities (used by teacher or students) (Moore et al., 2014), they were recommended to use during the teaching process. If the laboratory will be designed as inquiry-based, the simulations could be designed to use during the laboratory. During the laboratory, students could use the simulation through computers or iPads and students explored the content knowledge and experiment at the beginning of the class. During this process, some activity sheets could be given to students to write their evaluations related with the each process of experimentation. In addition, teaching assistants could guide the process by asking questions related with the procedures inside the simulations. While the teaching assistants explaining the concepts related with the experiments, the teacher could ask questions to trigger discussion with students. After this discussion, the assistant could show how the answer of the questions was achieved by doing the experiment in simulation. In addition some clicker questions could also be used like Phet Sims (Moore et. al., 2014), which could improve the discussion process. After this experience, students could begin to apply the experiment in reality. For the first, instead of video, assistants could show the experimental procedure by using the simulation, which could enhance the interaction with the students. Secondly, the students could bring their PC to conduct the experiment before the real experimentation, which enable them to compare their two activities.

- Simulations could also be used during the classroom in General Chemistry Lecture to explain the concepts related with the experiments. General Chemistry course is essential to learn the conceptual issues; these kinds of simulations could be provided in-class time for more inquiry-guided instruction. While different content simulations are valid in the online platforms, the main idea is to trigger students' thinking process during the simulation interaction. Therefore, the suggestions about the role of teachers, worksheets, discussion processes could also be applied in main lecture.

Through these scenarios, which could be expanded many, the role of the teaching assistant is important. This study showed that, even if the students see the process in advance, they still have some problems during the experimentation process as mentioned in the adoption-implementation part and also had a negative influence on students preparation process. These scenarios could help students to memorize the procedure during the experimentation process. In addition, in order to minimize this problem, the teaching assistants had also an important role to decrease the concern of the students. Beside their content knowledge and profession, their ability to ask critical questions, which could orient students' thinking and engagement for the course, is also essential for a laboratory course. In order to increase their teaching abilities, some in-service training or workshops could be organized by some faculty members or the institution about how to improve students' learning activities during their experimentation process. Moreover, the interaction between the faculty members and teaching assistants, which found not sufficient in this case, is important to support the teaching assistants' teaching abilities.

Some technological tools also could be implemented during the process. For example, iPad or mobile phones could be used as twofold:

- For one scenario, iPads or mobile phones could be beneficial for students to see and review the process by watching videos or simulations. If the OERs will be used during the teaching process, each student could follow the process in their own devices which the teaching assistants had a control on this process.

- For the second scenario, iPad could be used instead of laboratory book for a paperless process. For example, as a study of Hesser and Schwartz (2013), they designed their laboratory based on inquiry teaching method, which requires students to write the purpose and procedure of experiments by using iPad applications like UPAD. UPAD is an application, which enable users to write, draw, highlight and transform pdf files to different types. This kind of application could be implemented into the laboratory process by using iPad before, during and after the laboratory. The students could use the iPad instead of laboratory book to write the notes or calculations or they could write reports and send them through online platforms with teaching assistants.
- As the third scenario, UPAD could also be beneficial to improve the quality of the course. This application enables users to write personal notes or highlighted some parts on the documents. Through this opportunity, the users could share their personal evaluations related with the quality of online laboratory book, reports and their explanations and experiences related with the experiments. These evaluations could be discussed by teaching assistants and could be shared with other students. This approach could also be used in LMS platforms, which provide writing notes through Notes and Wiki features.

5.3.3.3 Assessment Process

Related with the assessment process, the quality and sequence of the evaluations were determined important for students' engagement and performance in the laboratory environment. While the questions in the quizzes had a standard flow, they were criticized to have explicit answers from the laboratory book. So that, some recommendations were offered as:

- Questions could be reviewed to be more directing students' critical thinking abilities. However, the time for the quizzes was very limited (approx. 5 min) in the classroom, these questions could be included into the pre-lab exercises within the resources in the course. They could contain some critical questions, which help the students learning activities in the environment.

- The videos could be designed as more interactive to engage learners into the process. This interaction could comprise quizzes (multiple choice, fill in the blank, drag and drop etc.), notes (pop-up text, key information, summary of the information) and provided by different platforms like H5P and HiHaHo. H5P also provided to create self-quizzes and presentations, which could also be used before and during the course.
- The sequence of the assessments was also defined as a problem, the students tended to ignore the critical parts of the course after finishing the pre-quizzes. Lack of post evaluation seemed to affect the students' behaviors during the laboratory environment. Some studies showed the importance of post-quizzes or evaluations to keep the students engaged during the course period so that some mini-quizzes or reports provided through the simulations could engage students to review the process while writing the report. Because the reports in the system were criticized as lack of personal evaluation and critical thinking, integration of reports and quizzes into simulation environment could help to minimize the problems. In addition, this process could enable personal evaluation of the students through the system**.**
- The assessment process could also be handled through LMS platforms like ODTU Class. Students could fill the quizzes or complete their report through this platform. ITS unit could provide alternatives on how to integrate the assessment process into LMS system but this scenario could be more meaningful by adding all the resources into an LMS system.

In addition, Domin (2007) highlighted that the students could be cognitively overloaded by both thinking of the theoretical concepts/principles and the procedural knowledge in expository laboratory so that the post-laboratory activities could be placed on the laboratory activities. Particularly, in order to minimize the cognitive load, these post-quizzes and post-laboratory activities could be developed.

However, solely the integration of the resources into the teaching process and the assessment practices did not provide major changes without the reconstruction of the problems in the components of the system. Each component had an interaction with and influence on other components. The students in the course should have more responsibility in their learning process with some proper guidance provided by the teaching assistants. Their preparation level for the course should be enriched with the pre-laboratory exercises enhanced by the resources in the course. The assessments should be redesigned to grasp the meaning of the experiments rather than memorizing some information in the experiment. Thus, while the resources provided minimal effect on teaching and learning experiences in the environment, they could facilitate to redesign and provide the activities and methods in GCLC system. Even if the system and the owners of the system were not seem to make major changes in the environment, some changes could affect other components in the system.

5.3.3.4 Performance Effect

The students in a laboratory environment different from traditional classrooms have to deal with the cognitive activities (conceptual, procedural knowledge, learning activities), psychomotor activities (how to conduct the experiment, how to use the equipment and materials, how to set up the experiment) and affective experiences (satisfaction, fear, happiness, feeling comfortable). For a meaningful learning, each three domain could be satisfied. In here, it is required to determine how the resources could help to satisfy each domain. Some possible suggestions were provided for each domain regarding the videos and simulations:

For *cognitive domain*, the OERs found to be more beneficial for procedural knowledge but lack of conceptual knowledge and some higher order thinking skills like interpretation and analysis.

- As the demand for some key knowledge for what to learn, why to learn and how to use the information, this information could be added to both videos and simulations instead of only showing how to conduct the experiment (see preparations for the course).
- While the length of the instructional videos is critical for the engagement of students, adding valuable information is a key to success of the resources. When working memory capacity and the performance of the learners were found correlated, eliminating the extraneous information for learners could be helpful to minimize the cognitive load (Danili and Reid, 2004). Hint and key knowledge could be used in videos to eliminate extraneous information (Long, Logan and Waugh, 2016). While the content videos could be divided into parts to decrease the cognitive load, experimental videos could be designed with some interactive elements to support the key knowledge about the experiments. Platforms like H5P provided interactive videos include summary information, pop-up texts which could be used to give key information about the experiments
- In this study, while the affective purposes found featured among three domains, some students were seeking to find some answers for the purposes to conduct the experiments whose cognitive expectations were higher than expected. While the students were seemed not to have satisfactory answers from laboratory book (the information in the laboratory book could also be reviewed) and cognitively overloaded by the teaching process, providing this information could be maintained by the resources and changes in the teaching process.
- More explicit purposes and outcomes should be defined for the course. While the discrepancy between the students and instructors' expectations from the course was valid in this case and in the literature, having a holistic approach to unify these expectations could minimize this problem. The interdisciplinary approach could also be effective here to redesign the content of the course

based on the needs for students that this design could guide the students to more focus on cognitive process.

For the *psychomotor domain*, which the students got more help while conducting the experiment and using the equipment, some suggestions could be reviewed.

- As the help of the visualization, the chemicals and the equipment could be explained by their characteristics more detailed. As Romiszowski outlined (1999), for simpler tasks, if the prior knowledge was insufficient, provide the knowledge by both explaining and demonstrating which is also works well with the cognitive domain requirements.
- Second, some useful information for preparing some set ups could be added. In here, the simulation environment could be more beneficial which could support the students' ability to use the equipment. Pop-up texts, feedbacks could be added to the resources, which guide the users about how to accomplish the task about the experiments. While the traditional laboratory is still an essential component for the facilitation of psychomotor skills, the safety concerns and lack of ability could prevent the improvements in these skills. Therefore, the OERs could provide some extra visuals, animations or practices on how to apply the procedure. For example, pop-up applications could be integrated into resources on how to handle a burette.

For the *affective domain*, which the participants mostly mentioned the benefits of the resources for their affective experiences, some recommendations are provided.

- The resources (especially the videos) provided most of the users a comfortable and self-reliant environment and they were mostly satisfied to use the resources. Beside the resources, teaching assistants and faculty members have a critical role for the students' experiences. Some suggestions could be helpful for them to keep the students' feelings alive in the environment. For example, Bretz, Fay, Bruck & Towns (2013) found that some faculty members aimed to support affective domain by linking the theoretical knowledge with the real-life scenarios and students' professional fields and interest. Moreover, linking the laboratory with the main lecture was defined an important determinant for supporting the content knowledge with the procedural knowledge. This strategy was also found as a desired strategy in this study that the students could feel more comfortable and satisfied by linking theoretical knowledge with procedural knowledge, which could also beneficial for their cognitive experiences.

- Online pre-lab exercises could have and affect on students' affective performances (help to understand the experiment, provide flexible and easier preparation than manual, increase the awareness of additional resources in the internet and increase in confidence for the experiments) (Chittleborough, Mocerino and Treagust, 2007). In here, as the visual materials were more preferred than the printed materials by the students for this case, their effect on the students' affective domain as a pre-lab exercise is not surprising. Thus, combining theoretical knowledge into the resources could attract the students' attention for the content.
- For the affective domain, beside the resources, the interaction between the students and faculty members/ teaching assistants is also prominent. They have a power to provide a comfortable environment for students to engage them into the process of learning. The laboratory has very strict rules because of its nature but it could be designed more enjoyable for students. Teaching assistants have a critical role here to provide comfortable environment for students.
- The features of the resources was also found important for some users especially for simulations, so that the visuals could be improved and more engaging activities could be provided (see the quality of the OERs in recommendations)

- In order to decrease the concerns and increase the familiarity with the laboratory environment, virtual laboratories with 3D environment could be designed to show the environment as in the current real laboratory.

Therefore, while the resources' effects on teaching and learning activities were focus on this study, different components of the system also analyzed because of having a dynamic relationship with each other so that some suggestions for science laboratory courses were provided through the integration of instructional resources in this case.

5.3.3.5 Encouragement

Encouraging students to use the resources could be mainly accomplished by faculty members and teaching assistants.

- Like in advertisement practices, e-mails were observed as an encouraging factor, which keep students on a stable usage profile in this study (see recommendations for advertisement).
- For the second issue, the bonus point were also suggested as an important factor, which is not surprising for the students who seek to get higher grades in the course. However, most of them preferred the bonus point instead of an effective point on grade in order to minimize the users' freedom to use the resources. While only watching the videos or implementing the simulations could not be a reliable activity to give bonus points, some evaluations or activities could be added into the resources and then the students could get some extra point to complete the activities. In addition, mobile platforms could also be critical that the students are not allowed to bring their PC so that the mobile adaptability of the resources could increase the use of the resources.
- Regarding the students' user profiles, still half of the students did not use the resources. Among the barriers to use the resources (interest for the course, effect of the resources, lack of information and lack of time), effect of the resources on students' performances was investigated as critical component.

While the content of the resources (see cognitive domain) and their correlation with the assessment part of the course are also important. The resources should provide different and valuable information rather than the other instructional resources in the course (laboratory book in this case) to motivate the students to use the resources.

- In addition, while some of the students' purposes for the course pointed getting higher grades from the course, the resources should provide some content for the assessment part. This could be achieved by adding valuable information into the resources, which are asked in the quizzes, or by adding some evaluations inside the resources, which could inform the students about the experiments (see assessment process).

Therefore, while the resources provide an optional user choice, the level of integration of the resources into the systems components (teaching method, teaching process, assessment, learning activities etc.) could increase the use of the resources.

REFERENCES

Abdulwahed, M., & Nagy, Z. K. (2009). Applying Kolb's Experiential Learning Cycle for Laboratory Education. *Journal of Engineering Education* , 283-294.

Abelson, H. (2008). The Creation of OpenCourseWare at MIT. *Journal of Science Education and Technology , 17* (2), 164-174.

Allen, G., Larsen, D. S., Guzman-Alvarez, A., Smith, A., Gamage, A., & Molinaro, M. (2015). Evaluating the effectiveness of the open-access ChemWiki resource as a replacement for traditional general chemistry textbooks. *Chemistry Education Research and Practice*, *16*(4), 939-948.

Arendt, A. A., & Shelton, B. E. (2009). Incentives and Disincentives for the Use of OpenCourseWare. *International Review of research in Open and Distance Learning , 10* (5), 1-25.

Arguel, A., & Jamet, E. (2009). Using video and static pictures to improve learning of procedural contents. *Computers in Human Behavior, 25*, 354-359.

Atkins, D.E., Brown, J.S., & Hammond, A.L. (2007). *A review of the open educational resources (OER) movement achievements, challenges, and new opportunities*. Retrieved May 8, 2017, from http://learn.creativecommons.org/wpcontent/uploads/2008/03/areviewoftheopeneducationalresourcesoermovement_bloglink.pdf

Aufschnaiter, C. v., & Aufschnaiter, S. v. (2007). University students' activities, thinking and learning during laboratory work. *European Journal of Physics , 28*, 51-60.

Ayres, P., Marcus, N., Chan, C., & Qian, N. (2009). Learning hand manipulative tasks: When instructional animations are superior to equivalent static representations. *Computers in Human Behavior, 25*, 348-353.

Banathy, B. H. (1988). Systems Inquiry in Education. *Systems Practice,1*(2), 193–212.

Banathy, B. H. (1992). *A Systems View of Education: Concepts and Principles for Effective Practice*. Englewood Cliffs, NJ: Educational Technology Publications Inc.

Banathy, B. H., & Jenlink, P. M. (2004). Systems inquiry and its application in education. In D. H. Jonassen (Ed.), *Handbook of Research on Educational Communications and Technology*, (pp. 37-57). Mahwah, NJ: Lawrence Erlbaum Associates.

Barros, B., Read, T., & Verdejo, M. F. (2008). Virtual Collaborative Experimentation: An Approach Combining Remote and Local Labs. *IEEE Transactions and Education , 51* (2), 242-250.

Belikov, O. M., & Bodily, R. (2016). Incentives and barriers to OER adoption : A qualitative analysis of faculty perceptions. *Open Praxis, 8*(3), 235–246.

Berg, B. L. (2009). *Qualitative Research Methods for the Social Sciences.* Boston: Pearson Education, Inc.

Berry, T., Cook, L., Hill, N., & Stevens, K. (2011). An Exploratory Analysis of Textbook Usage and Study Habits: Misperceptions and Barriers to Success. *College Teaching*, *59*(1), 31-39.

Bliss, J. T., Robinson, J. T., Hilton, J., & Wiley, D. A. (2013). An OER COUP: College Teacher and Student Perceptions of Open Educational Resources. *Journal of Interactive Media in Education*, 25. http://doi.org/10.5334/2013-04

Bloom, B.S., Englelhart, M.D., Furst, E.J., Hill, W.H., & Krathwohl, D.R. (1956). Taxonomy of educational objectives: The classification of educational goals. Handbook I: Cognitive Domain. New York, NY: Longman, Inc.

Bloom, B. S., Hastings, J. T., & Madaus, G. F. (1971). *Handbook on Formative and Summative Evaluation of Student Learning*. NY: McGraw-Hill.

Bogdan, R. C., & Biklen, S. K. (1998). *Qualitative Research in Education* (3rd edition). Needham Heights, MA: Allyn & Beacon.

Boschmann, E. (2003). Teaching Chemistry via Distance Education. *Journal of Chemical Education , 80* (6), 704-708.

Bos, N., Groeneveld, C., van Bruggen, J., & Brand-Gruwel, S. (2016). The use of recorded lectures in education and the impact on lecture attendance and exam performance. *British Journal of Educational Technology*, *47*(5), 906-917.

Brewer, S. E., Cinel, B., Harrison, M., & Mohr, C. L. (2013). First Year Chemistry Laboratory Courses for Distance Learners: Development and Transfer Credit Acceptance. *The International Review of Research in Open and Distance Learning , 14* (3), 488-507.

Bretz, S. L., Fay, M., Bruck, L. B., & Towns, M. H. (2013). What Faculty Interviews Reveal about Meaningful Learning in the Undergraduate Chemistry Laboratory. *Journal of Chemical Education, 90*(3), 281-288.

Broman, K., & Simon, S. (2015). Upper Secondary School Students??? Choice and Their Ideas on How To Improve Chemistry Education. *International Journal of Science and Mathematics Education, 13*(6), 1255–1278.

Bruck, A. D., & Towns, M. (2013). Development, Implementation, and Analysis of a National Survey of Faculty Goals for Undergraduate Chemistry Laboratory. *Journal of Chemical Education*, *90*(6), 685-693.

Burewicz, A., & Miranowicz, N. (2006). Effectiveness of multimedia laboratory instruction. *Chemistry Education Research and Practice*, *7*(1), 1-12.

Butcher, N. (2009). *Open Educational Resources and Higher Education.* Retrieved from http://oerworkshop.weebly.com/uploads/4/1/3/4/4134458/03_open_educational_resources_and_higher_education.pdf

Cakmak, T., Ozel, N., & Yilmaz, M. (2013). Evaluation of OpenCourseWare Initiatives within the Scope of Digital Literacy Skills: Turkish OpenCourseWare Consortium Case. *2nd World Conference on Educational Technology Researches* (pp. 65-70). Procedia-Social and Behavioral Sciences.

Carson, S., Kanchanaraksa, S., Gooding, I., Mulder, F., & Schuwer, R. (2012). Impact of OpenCourseWare Publication on Higher Education Participation and Student Recruitment. *The International Review of Research in Open and Distance Learning , 13* (4), 19-32.

Castro-Alonso, J. C., Ayres, P., & Paas, F. (2016). Comparing apples and oranges? A critical look at research on learning from statics versus animations. *Computers & Education, 102*, 234-243.

Checkland, P., & Poulter, J. (2006). *Learning For Action: A Short Definitive Account of Soft Systems Methodology, and its use Practitioners, Teachers and Students*. Chichester: John Wiley and Sons Ltd.

Chen, D., & Stroup, W. (1993). General System Theory: Toward a Conceptual Framework for Science and Technology Education for All. *Journal of Science Education and Technology, 2*(3).

Chen, Q. (2010). Use of Open Educational Resources: Challenges and Strategies. *Third International Conference, ICHL* (pp. 339-351). Beijing: Springer Berlin Heidelberg.

Chester, A., Buntine, A., Hammond, K., & Atkinson, L. (2011). Podcasting in Education: Student Attitudes, Behaviour and Self-Efficacy. *Journal Of Educational Technology & Society*, (2), 236.

Chittleborough, G. D., Mocerino, M., &Treagust, D. F. (2007). Achieving greater feedback and flexibility using online pre-laboratory exercises with non-major chemistry students. *Journal of Chemical Education, 84*(5), 884-888.

Coleman-Prisco, V. (2017). Factors Influencing Faculty Innovation and Adoption of Open Educational Resources in United States Higher Education. *International Journal of Education and Human Developments, 3*(4).

Cooper, M., & Kerns, T. (2006). Changing the laboratory: Effects of a laboratory course on students' attitudes and perceptions. *Journal of Chemical Education, 83*(9), 1356-1361.

Corter, J. E., Esche, S. K., Chassapis, C., Ma, J., & Nickerson, J. V. (2011). Process and learning autcomes form remotely-operated, simulated, and hands on student laboratories. *Computers & Education , 57*, 2054-2067.

Creswell, J. W. (2007). *Qualitative Inquiry & Research Design Choosing Among Five Approaches.* Thousand Oaks, CA: Sage.

Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.* Thousand Oaks, CA: Sage Publications.

Creswell, J. W. (2012). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research* (4th ed.). Boston: Pearson Education, Inc.

D'Antoni, S. (2008). *Open Educational Resources the way forward, deliberations of an international community of interest.* UNESCO.

Dalgarno, B., Bishop, A. G., Adlong, W., & Bedgood, D. R. (2009). Effectiveness of a Virtual Laboratory as a preparatory resource for Distance Education chemistry students. *Computers and Education, 53*(3), 853–865.

Danili, E., & Reid, N. (2004). Some strategies to improve performance in school chemistry, based on two cognitive factors. *Research in Science & Technological Education*, *22*(2), 203-226.

Darrah, M., Humbert, R., Finstein, J., Simon, M., & Hopkins, J. (2014). Are virtual labs as effective as hands-on labs for undergraduate physics? A comparative study at two major universities. *Journal of Science Education and Technology, 23*(6), 803-814.

Davis, H. C., Carr, L., Hey, J. M., Howard, Y., Millard, D., Morris, D., & White, S. (2010). Bootstrapping a Culture of Sharing to Facilitate Open Educational Resources. *IEEE Transactions on Learning Technologies , 3* (2), 96-109.

Deacon, C., & Hajek, A. (2010). Student Perceptions of the Value of Physic Laboratories. *International Journal of Science Education , 33* (7), 943-977.

Deimann, M., & Farrow, R. (2013). Rethinking OER and their Use: Open Education as Bildung. *The International Review of Research in Open and Distance Learning , 14* (3), 344-360.

De Jong, T., & Van Joolingen, W. R. (1998). Scientific Discovery Learning with Computer Simulations of Conceptual Domains. *Review of Educational Research*, *68*(2), 179–201.

DeKorver, B. K., & Towns, M. H. (2015). General Chemistry Students' Goals for Chemistry Laboratory Coursework. *Journal Of Chemical Education*, *92*(12), 2031-2037.

DeKorver, B. K., & Towns, M. H. (2016). Upper-level undergraduate chemistry students’ goals for their laboratory coursework. *Journal of Research in Science Teaching, 53*(8), 1198-1215.

De Liddo, A. (2010). From open content to open thinking. In *World Conference on Educational Multimedia, Hypermedia and Telecommunications* (Ed-Media 2010). Toronto, Canada.

de los Arcos, B., Farrow, R., Perryman, L.-A., Pitt, R. & Weller, M. (2014). OER Evidence Report 2013-2014. OER Research Hub. Retrieved from http://oerresearchhub.org/about-2/reports/

de los Arcos, B., Farrow, R., Pitt, R., Perryman, L-A., Weller, M., & McAndrew, P. (2015). OER Research Hub Data 2013-2015: Informal Learners. Retrieved from http://oro.open.ac.uk/47931/1/Educators_FINAL_OERRHData.pdf

de los Arcos, B., Farrow, R., & McAndrew, P. (2016). Adapting the Curriculum : How K-12 Teachers Perceive the Role of Open Educational Resources. *Journal of Online Learning Research*, *2*(1), 23–40.

Denzin, N. K., & Lincoln, Y. S. (2005). The SAGE Handbook of Qualitative Research. Thousand Oaks, CA: Sage.

DeVries, I. (2013). Evaluating Open Educational Resources: Lessons Learned. *2nd World Conference on Educational Technology Researches* (pp. 56-60). Canada: Procedia-Social and Behavioral Sciences.

Domin, D. S. (1999). A Review of Laboratory Instruction Styles. *Journal of Chemical Education , 76* (4), 543-547.

Domin, D. S. (2007). Students' perceptions of when conceptual development occurs during laboratory instruction. *Chemistry Education Research and Practice , 8* (2), 140-152.

Dupagne, M., Millette, D. M., & Grinfeder, K. (2009). Effectiveness of Video Podcast Use as a Revision Tool. *Journalism & Mass Communication Educator*, *64*(1), 54-70.

Duval, E., & Wiley, D. (2010). Guest Editorial: Open Educational Resources. *IEEE Transactions on Learning Technologies , 3* (2), 83-84.

Elf, M., Ossiannilsson, E., Neljesjö, M., & Jansson, M. (2015). Implementation of open educational resources in a nursing programme: experiences and reflections. *Open Learning*, *30*(3), 252-266.

Elliot, M. J., Stewart, K. K., & Lagowski, J. J. (2008). The Role of the Laboratory in Chemistry Education. *Journal of Chemical Education , 85* (1), 145-149.

Evans, H. (2014). An Experimental Investigation of Videotaped Lectures in Online Courses. *Techtrends*, *58*(3), 63-70.

Farrow, R., Pitt, R., de los Arcos, B., Perryman, L.-A., Weller, McAndrew, P. (2015). Impact of OER use on teaching and learning: Data from OER Research Hub (2013–2014). *British Journal of Educational Technology, 46*(5), 972–976.

Feldman-Maggor, Y., Rom, A., & Tuvi-Arad, I. (2016). Integration of open educational resources in undergraduate chemistry teaching-a mapping tool and lecturers' considerations. *Chemistry Education Research And Practice, 17*(2), 283-295.

Field, A. (2009). *Discovering Statistics Using SPSS* (3rd ed.). Thousand Oaks, CA: Sage.

Figueiredo, M., Neves, J., Gomes, G., & Vicente, H. (2016). Assessing the Role of General Chemistry Learning in Higher Education. *Procedia - Social and Behavioral Sciences*, *228*, 161–168.

Finkelstein, N. D., Adams, W. K., Keller, C. J., Kohl, P. B., Perkins, K. K., Podolefsky, N. S., & Reid, S. (2005). When learning about the real world is better done virtually: A study of substituting computer simulations for laboratory equipment. *Physical Review Special Topics - Physics Education Research, 1*(1).

Firestone, W. A. (1987). Meaning in Method: The rhetoric of quantitative and qualitative research. *Educational Researcher, 16*(7), 187-205.

Fischer, L., Hilton, J., Robinson, T., & Wiley, D. (2015). A multi-institutional study of the impact of open textbook adoption on the learning outcomes of post-secondary students. *Journal of Computing In Higher Education*, *27*(3), 159-172.

Forward, M. L. (2012). OpenCourseWare. In D. G. Oblinger (Ed.). *Game Changers: Education and Information Technologies* (pp. 291-299). EDUCAUSE.

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to Design and Evaluate Research in Education.* New York, NY: The McGraw-Hill Companies Inc.

Gabel, D. (1999). Improving Teaching and Learning through Chemistry Education Research: A Look to the Future. *Journal of Chemical Education, 76*(2-4), 548-554.

Gagnon, Y.-C. (2010). *The Case Study as Research Method.* Canada: Presses de I'Universite du Quebec.

Gall, M. D., Gall, J. P., & Borg, W. R. (2003). *Educational Research: An Introduction*, (8th ed.). Boston, MA: Pearson.

Galloway, K. R., & Bretz, S. L. (2015). Measuring Meaningful Learning in the Undergraduate Chemistry Laboratory: A National, Cross-Sectional Study. *Journal of Chemical Education*, pp. 2006–2018.

Galloway, K., & Bretz, S. (2016). Video episodes and action cameras in the undergraduate chemistry laboratory: Eliciting student perceptions of meaningful learning. *Chemistry Education Research and Practice*, *17*(1), 139-155.

Geith, C., & Vignare, K. (2008). Access to Education with Online Learning and Open Educational Resources: Can They Close the Gap? *Journal of Asynchronous Learning Networks , 12*(1), 1-22.

Gillham, B. (2000). *Case Study Research Methods*. London: Continuum International Publishing.

Gryczka, P., Klementowicz, E., Montclare, J., Sharrock, C., & Maxfield, M. (2016). LabLessons: Effects of Electronic Prelabs on Student Engagement and Performance. *Journal of Chemical Education*, *93*(12), 2012-2017.

Hawkes, S. J. (2004). Chemistry is not a laboratory science. *Journal of Chemical Education, 81* (9).

Herrington, D., & Nakhleh, M. (2003). What Defines Effective Chemistry Laboratory Instruction? Teaching Assistant and Student Perspectives. *Journal Of Chemical Education*, *80*(10), 1197-1205.

Hesser, T. L. |Schwartz. P. M. (2013). iPads in the Science Laboratory: Experience in Designing and Implementing a Paperless Chemistry Laboratory Course. *Journal of STEM Education: Innovations and Research*, *14*(2), 5–9.

Hill, J. L. and Nelson, A. (2011). New technology, new pedagogy? Employing video podcasts in learning and teaching about exotic ecosystems. *Environmental Education Research, 17* (3), 393-408.

Hilton III, J. (2016). Open educational resources and college textbook choices: a review of research on efficacy and perceptions. *Educational Technology Research and Development*, *63*, 573-590.

Hodgkinson-Williams, C. (2010). *Benefits and challenges of OER for higher education institutions.* Retrieved from http://oldwebsite.col.org/SiteCollectionDocuments/ OER_BenefitsChallenges_presentation.pdf

Hofstein, A. (2004). The Laboratory in Chemistry Education: Thirty Years of Experience with Developments, Implementation and Research. *Chemistry Education: Research and Practice , 5* (3), 247-264.

Hofstein, A., & Lunetta, V. N. (2004). The Laboratory in Science Education: Foundations for the Twenty-First Century. *Science Education , 88* (1), 28-54.

Högström P., Ottander C., & Benckert S. (2010). Lab work and learning in secondary school chemistry: the importance of teacher and student interaction, *Res. Sci. Educ.*, *40*, 505–523.

Hu, E., Li, Y., Li, J., & Huang, W. H. (2015). Open educational resources (OER) usage and barriers: a study from Zhejiang University, China. *Educational Technology Research and Development*, *63*(3), 957–974.

Hylen, J. (2005). *Open Educational Resources: Opportunities and Challenges.* OECD.

Ives, C., & Pringle, M. M. (2013). Moving to Open Educational Resources at Athabasca University: A Case Study. *The International Review of Research in Open and Distance Learning , 14* (2), 1-14.

Jelfs, A., & Whitelock, D. (2000). The notion of presence in virtual learning environments: what makes the environment “real”. *British Journal Of Educational Technology*, *31*(2), 145-152.

Johnson, R. B., & Christensen, L. (2014). *Educational Research: Quantitative, Qualitative, and Mixed Approaches* (5th ed.). Thousand Oaks, CA: Sage.

Johnstone, A. H., & Al-Shualili, A. (2001). Learning in the laboratory: Some throughts from literature. *University Chemistry Education , 5*, 42-51.

Johnstone, A. H., Watt, A., & Zaman, T. U. (1998). The Students' Attitude and Cognition Change To a Physics Laboratory. *Physics Education*, *33*(1), 22-29.

Jolley, D. F., Wilson, S. R., Kelso, C., O'Brien, G., & Mason, C. E. (2016). Analytical Thinking, Analytical Action: Using Prelab Video Demonstrations and e-Quizzes To Improve Undergraduate Preparedness for Analytical Chemistry Practical Classes. *Journal of Chemical Education*, *93*(11), 1855-1862.

Jordan, J., Box, M., Wolfe, M., Gallardo-Williams, M., Eguren, K., Parker, T., & Saraldi-Gallardo, V. (2016). Effectiveness of Student-Generated Video as a Teaching Tool for an Instrumental Technique in the Organic Chemistry Laboratory. *Journal of Chemical Education*, *93*(1), 141-145.

Judith, K., & Bull, D. (2016). Assessing the potential for openness: A framework for examining course-level OER implementation in higher education. *Education Policy Analysis Archives*, p. 42.

Jung, E., Bauer, C., & Heaps, A. (2017). Strategic Implementation of Open Educational Resources in Higher Education Institutions. *Educational Technology*, *57*(2), 78-84.

Karunanayaka, S. P., Naidu, S., Rajendra, J. C. N., & Ratnayake, H. U. W. (2015). From OER to OEP: Shifting Practitioner Perspectives and Practices with Innovative Learning Experience Design. *Open Praxis, 7*(4), 339–350.

Knox, J. (2013). Five Critiques of the Open Educational Resources Movement. *Teaching in Higher Education , 18* (8), 821-832.

Kozinska, K., Kursun, E., Wilson, T., McAndrew, P., Scanlon, E., Jones, A. (2010). Are Open Educational Resources the Future of e-learning? *3rd International Conference on Innovations in Learning for the Future 2010* (pp. 34-44). Istanbul Kultur University Publication.

Krathwohl, D. R. (2002). A Revision of Bloom's Taxonomy: An Overview. *Theory Into Practice*, (4), 212.

Kirschner, P., Sweller, J., & Clark, R. (2006). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *41*(2), 75-86.

Kursun, E. (2011). *An investigation of incentives, barriers and values about the OER movement in Turkish universities: implications for policy framework* (Doctoral Dissertation). METU, Ankara.

Kursun, E., Cagiltay, K., & Can, G. (2014). An Investigation of Faculty Perspectives on Barriers, Incentives, and Benefits of the OER Movement in Turkey. *International Review of Research in Open and Distance Learning, 15* (6).

Lane, A., & McAndrew, P. (2010). Are open educational resources systematic or systemic change agents for teaching practice. *British Journal of Educational Technology, 41*(6), 952-962.

Leontyev, A., & Baranov, D. (2013). Massive open online courses in chemistry: A comparative overview of platforms and features. *Journal of Chemical Education*, *90*(11), 1533–1539.

Lincoln, Y. S., & Guba, E. G. (1981). *Naturalistic Inquiry*. Newbury Park, CA: Sage.

Long, T., Waugh, M., & Logan, J. (2016). Students' Perceptions of the Value of Using Videos as a Pre-class Learning Experience in the Flipped Classroom. *Techtrends*, *60*(3), 245-252.

Ma, J., & Nickerson, J. V. (2006). Hands-on Simulated, and Remote Laboratories: A Comparative Literature Review. *ACM Computing Surveys , 38*(3), 1-24.

Mackintosh, W. (2012). Opening education in New Zealand: A snapshot of a rapidly evol- ving OER ecosystem. In J. Glennie, K. Harley, N. Butcher, & T. van Wyk (Eds.), Open educational resources and change in higher education: Reflections from practice (pp. 263–279). Vancouver, Canada.

Martin, B. L. and Briggs, L. J. (1986). The affective and cognitive domains: Integration for instruction and research. Englewood Cliffs, NJ: LawrenceErlbaumAssociates.

Martin, B. L., & Reigeluth, C. M. (1999). Affective Education and the Affective Domain: Implications for Instructional-Design Theories and Models. In C. M. Reigeluth (Ed), *Instructional Design Theories and Models: A New Paradigm of Instructional Theory* (pp. 485-510). Mahwah, NJ: Lawrence Erlbaum Associates.

Martinez-Jimenez, P., Pontes-Pedrajas, A., Polo, J. & Climent-Bellido, M. S. (2003). Learning in Chemistry with Virtual Laboratories *Journal of Chemical Education, 80*(3) p346-352.

Masterman, L., & Wild, J. (2011). *OER Impact Study: Research Report.* JISC. Retrieved from https://weblearn.ox.ac.uk/access/content/group/ca5599e6-fd26-4203-b416-f1b96068d1cf/Research%20Project%20Reports/OER%20Projects%202011-2014/JISC%20OER%20Impact%20Study%20Research%20Report%20v1-0.pdf

McAndrew & Farrow (2013). Open Education Research: From the Practical to the Theoretical. In R. McGreal, W. Kinuthia & S. Marshall (Eds.), *Open Educational Resources: Innovation, Research and Practice* (65-78). Vancouver, Canada: Commonwealth of Learning and Athabasca University

McGarr, O. (2009). A review of podcasting in higher education: Its influence on the traditional lecture. *Australasian Journal of Educational Technology, 25*(3), 309-321.

McKerlich, R., Ives, C., & McGreal, R. (2013). Measuring Use and Creation of Open Educational Resources in Higher Education. *International Review of Research In Open and Distance Learning, 14*(4).

McKinney, D., Dyck, J., & Luber, E. (2009). iTunes University and the classroom: Can podcasts replace Professors?. *Computers & Education*, *52*(3), 617-623.

Merriam, S. B. (2009). *Qualitative Research: A Guide to Design and Implementation.* San Francisco, CA: Josey- Bass.

Miles, M. B., & Huberman, A. M. (1994). Qualitative Data Analysis: An Expanded Sourcebook. Thousand Oaks, CA: Sage.

Mintzes, J. J., Wandersee, J. H., & Novak, J. D. (2005). *Assessing Science Understanding: A Human Constructivist View*. San Diego: Elsevier.

MIT (2006). *2005 Program Evaluation Findings Report.* Boston: MIT OCW.

MIT (2017). *MIT Monthly Reports*. Retrieved from https://ocw.mit.edu/about/site-statistics/monthly-reports/

Moore, E. B., Herzog, T. A., & Perkins, K. K. (2013). Interactive simulations as implicit support for guided-inquiry. *Chem. Educ. Res. Pract.*, *14*(3), 257–268

Moore, E., Chamberlain, J., Perkins, K., & Parson, R. (2014). PhET interactive simulations: Transformative tools for teaching chemistry. *Journal Of Chemical Education*, *91*(8), 1191-1197.

Mooring, S., Mitchell, C., & Burrows, N. (2016). Evaluation of a Flipped, Large-Enrollment Organic Chemistry Course on Student Attitude and Achievement. *Journal of Chemical Education*, *93*(12), 1972-1983.

Muganda, C. K., Samzugi, A. S., & Mallinson, B. J. (2016). Analytical Insights on the Position, Challenges, and Potential for Promoting OER in ODeL Institutions in Africa. *The International Review of Research in Open and Distributed Learning*, *17*(4).

Mulder, F. (2013). The LOGIC of National Policies and Strategies for Open Educational Resources. *The International Review of Research in Open and Distributed Learning*, *17*(2).

Murphy, A. (2013). Open educational practices in higher education: institutional adoption and challenges. *Distance Education* , *34* (2), 201-217.

Nadelson, L. S., Scaggs, J., Sheffield, C., & Mcdougal, O. M. (2015). Integration of Video-Based Demonstrations to Prepare Students for the Organic Chemistry Laboratory. *Journal of Science Education And Technology*, *24*(4), 476-483

Najjar, N. J. (1996). Multimedia Information and Learning, *Journal of Educational Multimedia and Hypermedia, 5* (2), 129-150

Nickerson, J. V., Corter, J. E., Esche, S. K., & Chassapis, C. (2007). A model for evaluating the effectiveness of remote engineering laboratories and simulations in education. *Computers & Education* , *49*, 708-725.

O'Bannon, B., Lubke, J., Beard, J., & Britt, V. (2011). Using podcasts to replace lecture: Effects on student achievement. *Computers and Education*, *57*(3), 1885-1892.

Obenland, C., Kincaid, K., & Hutchinson, J. (2014). A general chemistry laboratory course designed for student discussion. *Journal of Chemical Education*, *91*(9), 1446-1450.

OECD (2007). *Giving Knowledge for Free: The Emergence of Open Educational Resources*, Paris: OECD Publishing.

Olcott Jr., D. (2012). OER Perspectives: Emerging Issues for Universities. *Distance Education , 33* (2), 283-290.

Okonkwo, C. A. (2012). A Needs Assessment of ODL Educators to Determine their Effective Use of Open Educational Resources. *The International Review of Research in Open and Distance Learning , 13* (4), 293-312.

Open Education Consortium (2017). *About Open Education Consortium*. Retrieved from http://www.oeconsortium.org/about-oec/

OpenLearn (2017). *About OpenLearn*. Retrieved from http://www.open.edu/openlearn/about-openlearn/welcome-openlearn-free-learning-the-open-university

OpenStax CNX (2017). *About OpenStax CNX*. Retrieved from https://cnx.org/about

Panke, S., & Seufert, T. (2012). What's Educational about Open Educational Resources? Different Theoretical Lenses for Conceptualizing Learning with OER. *E-Learning and Digital Media*.

Patton, M. Q. (1990). *Qualitative Evaluation and Research Methods*. Newbury Park, CA: Sage.

Patton, M. Q. (2002). *Qualitative Research & Evaluation Methods* (3rd edition). Thousand Oaks: CA, Sage.

Pekdağ, B. (2010). Kimya Öğreniminde Alternatif Yollar: Animasyon, Simülasyon, Video ve Multimedya ile Öğrenme. *Journal of Turkish Science Education, 7*(2), 79–110.

Pierce, M. (2016). Looking at OER with a Critical Eye: Strengthening OER Initiatives by Focusing on Student Learning. *Community & Junior College Libraries*, 1–7.

Pitt, R. (2015). Mainstreaming open textbooks: Educator perspectives on the impact of OpenStax college open textbooks. *International Review of Research in Open and Distance Learning*, *16*(4), 133–155.

Phalachandra, B., & Abeywardena, I.S. (2016). *Open Educational Resources in the Commonwealth 2016*. S. Mishra & I.S. Abeywardena (Eds.). Burnaby, Canada: Commonwealth of Learning.

Phelan, L. (2012). Politics, practices, and possibilities of open educational resources. *Distance Education , 33*(2), 279-282.

Pogačnik, L., & Cigić, B. (2006). How to motivate students to study before they enter the lab. *Journal of Chemical Education*, *83*(7), 1094-1098.

Potkonjak, V., Gardner, M., Callaghan, V., Mattila, P., Guetl, C., Petrović, V. M., & Jovanović, K. (2016). Virtual Laboratories for Education in Science, Technology, and Engineering: a Review. *Computers & Education*, *95,* 309–327

Powell, C. B., & Mason, D. S. (2013). Effectiveness of Podcasts Delivered on Mobile Devices as a Support for Student Learning During General Chemistry Laboratories. *Journal of Science Education and Technology*, *22*(2), 148–170.

Pyatt, K., & Sims, R. (2012). Virtual and Physical Experimentation in Inquiry-Based Science Labs: Attitudes, Performance and Access. *Journal Of Science Education and Technology*, (1), 133.

Reid, N., & Shah, I. (2007). The role of laboratory work in university chemistry. *Chemistry Education Research and Practice, 8*(2), 172-185.

Reid, S. (2016). A flipped classroom redesign in general chemistry. *Chemistry Education Research and Practice, 17*(4), 914-922.

Reigeluth, C. M., & Moore, J. (1999). Cognitive Education and Cognitive Domain. In C. M. Reigeluth (Ed.), *Instructional Design Theories and Models: A New Paradigm of Instructional Theory* (pp. 51-68). Mahwah, NJ: Lawrence Erlbaum Associates.

Richards-Babb, M., Smith, V. J., Xu, M., & Curtis, R. (2014). Problem Solving Videos for General Chemistry Review: Students' Perceptions and Use Patterns. *Journal of Chemical Education, 91*(11), 1796-1803.

Richter, T.; Ehlers, U. D. (2010). Barriers and Motivators for Using Open Educational Resources in Schools. *In Open ED 2010 Proceedings*. Barcelona: UOC, OU, BYU.

Richter, T., & McPherson, M. (2012). Open Educational Resources: Education for the World?. *Distance Education, 33*(2), 201-219.

Rolfe, V. (2012). Open educational resources: staff attitudes and awareness. *Research in Learning Technology, 20*, 1-13.

Rollnick, M., Zwane, S., Staskun, M., Lotz, S., & Green, G. (2001) Improving pre-laboratory preparation of first year university chemistry students. I*nternational Journal of Science Education, 23*(10).

Romiszovski, A. (1999). The Development of Physical Skills: Instruction in the Psychomotor Domain. In C. M. Reigeluth (Ed.), *Instructional Design Theories and Models: A New Paradigm of Instructional Theory* (pp. 457-482). Mahwah, NJ: Lawrence Erlbaum Associates.

Rutten, N., van Joolingen, W. R., & van der Veen, J. T. (2012). The learning effects of computer simulations in science education. *Computers & Education, 58*, 136-153.

Sauter, M., Uttal, D., Rapp, D., Downing, M., & Jona, K. (2013). Getting real: the authenticity of remote labs and simulations for science learning. *Distance Education, 34*(1), pp. 37-47.

Scalise, K., Timms, M., Moorjani, A., Clark, L., Holtermann, K., & Irvin, P. S. (2011). Student learning in science simulations: Design features that promote learning gains. *Journal of Research in Science Teaching, 48*(9), 1050–1078.

Scanlon, E. (2012). Open educational resources in support of science learning: tools for inquiry and observation. *Distance Education, 33*(2), 221-236.

Shelton, B. E., Duffin, J., Wang, Y., & Ball, J. (2010). Linking OpenCourseWares and open education resources: creating an efective serach and recommendation system. *1st Workshop on Recommender Systems for Technology Enhanced Learning* (pp. 2865-2870). Utah: Procedia Computer Science I.

Shibley Jr., I. A., & Zimmaro, D. M. (2002). The Influence of Collaborative Learning on Student Attitudes and Performance in an Introductory chemistry Laboratory. *Journal of Chemical Education*, *79*(6), 745.

Simons, H. (2009). *Case Study Research in Practice.* London: Sage.

Sirhan, G. and Reid, N. 2001. Preparing the mind of the learner – part 2. *University Chemistry Education*, *5*, 52–8.

Skoumios, M., & Passalis, N. (2010). Chemistry Laboratory Activities: The Link between Practice and Theory. *The International Journal of Learning, 17* (6), 101-114.

Stake, R. E. (1995). *The Art of Case Study Research*. London: Sage.

Stake, R. E. (2008). Qualitative Case Studies. In N. K. Denzin, & S. L. Yvonna (Eds.), *Strategies of Qualitative Inquiry* (pp. 119-149). California: Sage.

Stowe, R. A. (1973). Research and the Systems Approach as Methodologies for Education. *AV Communication Review, 21*(2).

Tatli, Z., & Ayas, A. (2012). Virtual Chemistry Laboratory: Effect of Constructivist Learning Environment. *Turkish Online Journal of Distance Education, 13* (1), 183-199.

Taylor, J. C. (2007). Open CourseWare Futures: Creating a Parallel Universe. *e-JIST, 10* (1).

Tesch, R. (1990). *Qualitative research: Analysis types and software tools*. New York: Falmer.

The Boston Consulting Group (2013). *The Open Education Resources ecosystem: An evaluation of the OER movement's current state and its progress toward mainstream adoption*. Retrieved from https://www.hewlett.org/wpcontent/uploads/2016/08/The%20Open%20Educational%20Resources%20Ecosystem.pdf

Tina, W. (2008). New Ways of Mediating Learning: Investigating the implications of adopting open educational resources for tertiary education at an institution in the United Kingdom as compared to one in South Africa. *International Review of Research In Open And Distance Learning, 9*(1).

Tobin, K. G. (1990). Research on science laboratory activities. In pursuit of better questions and answers to improve learning. *School Science and Mathematics, 90*, 403–418.

Tsekleves, E., Aggoun, A., & Cosmas, J. (2013). Investigating the use and effectiveness of diverse types of materials in the delivery and support of lab sessions for multimedia subjects and students. *British Journal of Educational*

Technology, 44(5), 857–868.

Tuomi, I. (2013). Open Educational Resources and the Transformation of Education. *European Journal of Education, 48*(1), 58-78.

Tüysüz, C. (2010). The effect of the virtual laboratory on students' achievement and attitude in chemistry. *International Online Journal of Educational Sciences*, pp. 37–53.

UNESCO. (2011). *Guidelines for open educational resources (OER) in higher education.* Retrieved from http://unesdoc.unesco.org/images/0021/002136/213605e.pdf

Xia, J. (2013). Let us take a Yale open course: a Chinese view of open educational resources provided by institutions in the West. *Journal of Computer Assisted Learning , 29,* 122-137.

Velazquez-Marcano, A., V., Williamson, V. M., Ashkenazi. G., Tasker, R.., & Williamson, K. C. (2004). The Use of Video Demonstrations and Particulate Animation in General Chemistry. *Journal of Science Education and Technology*, (3), 315.

Walton, D. (2004). Modeling organizational systems: Banathy's three lenses revisited. *Systemic Practice and Action Research*, *17*(4), 265-284.

Weaver, G. C.; Sturtevant, H. G. (2015). Design, Implementation, and Evaluation of a Flipped Format General Chemistry Course. *J. Chem. Educ., 92* (9), 1437−1448.

Weller, M., de los Arcos, B., Farrow, R., Pitt, B., & McAndrew, P. (2015). The Impact of OER on Teaching and Learning Practice. *Open Praxis, 7*(4).

Wiley D., Bliss T.J., McEwen M. (2014) Open Educational Resources: A Review of the Literature. In: Spector J., Merrill M., Elen J., Bishop M. (Eds.), *Handbook of Research on Educational Communications and Technology*. Springer, New York, NY

Wiley, D., Hilton, J., Ellington, S., & Hall, T. (2012). A Preliminary examination of the cost savings and learning impacts of using open textbooks in middle and high school science classes. *International Review of Research In Open And Distance Learning*, *13*(3), 262-276.

Winberg, T., Anders, C., & Berg, R. (2007). Students' cognitive focus during a chemistry laboratory exercise: Effects of a computer-simulated prelab. *Journal of Research In Science Teaching*, *44*(8), 1108-1133.

Woodfield, B. F., Catlin, H. R., Waddoups, G. L., Moore, M. S., Swan, R., Allen, R., & Bodily, G. (2004). The Virtual ChemLab project: A realistic and sophisticated simulation of inorganic qualitative analysis. *Journal of Chemical Education, 81*(11), 1672–1678.

Yin, R. K. (2009). *Case Study Research Design and Methods.* California: Sage.

Yin, R. K. (2011). *Qualitative Research from Start to Finish.* NY: Guilford Publications.

APPENDIX A

TURKISH VERSION OF OCW QUESTIONNAIRE

1. Fakülteniz:
2. Bölümünüz:
3. Sınıfınız:
4. Cinsiyetiniz:
5. Genel Not Ortalamanız:
6. Genel Kimya Dersinizin Kodu:
7. Genel Kimya dersini kaçıncı kez alıyorsunuz:
8. Genel Kimya Laboratuvarında toplam kaç deney yaptınız:
9. ODTÜ'nün Açık Ders Malzemeleri portalında (ocw.metu.edu.tr) bulunan "Genel Kimya Laboratuvarı Deneyleri" ders malzemelerinden (deney videoları, sanal deneyler) haberiniz var mı?
   - ☐ Evet
   - ☐ Hayır

10. Eğer 9. soruya cevabınız evet ise nasıl haberiniz oldu?
    - ☐ Broşür
    - ☐ Arkadaş
    - ☐ Ders Asistanları
    - ☐ Dersin Öğretim Üyesi
    - ☐ Medya Haberleri

☐ Diğer:____
____

11. ODTÜ nün Açık Ders Malzemeleri portalında (ocw.metu.edu.tr) bulunan "Genel Kimya Laboratuvarı Deneyleri" ders malzemelerini kullandınız mı?
    ☐ Evet
    ☐ Hayır

12. Eğer 11. Soruya cevabınız hayır ise neden kullanmadığınızı belirtiniz.
    ____
    ____
    ____
    ____
    ____
    ____
    ____
    ____

11. soruda HAYIR cevabını verdiyseniz anketi burada bırakabilirsiniz. Katılımınız için teşekkür ederiz

13. ODTÜ'nün Açık Ders Malzemeleri portalında (ocw.metu.edu.tr) bulunan "Genel Kimya Laboratuvarı Deneyleri" ders malzemelerini kullanma sıklığınız nedir?
    ☐ Her laboratuvardan önce
    ☐ Her laboratuvardan sonra
    ☐ Her laboratuvardan önce ve sonra
    ☐ Ara sıra bazı laboratuvarlardan önce
    ☐ Ara sıra bazı laboratuvarlardan sonra
    ☐ Ara sıra bazı laboratuvarlardan önce ve sonra
    ☐ Sadece bir kez kullandım

14. ODTÜ nün Açık Ders Malzemeleri portalında (ocw.metu.edu.tr) bulunan "Genel Kimya Laboratuvarı Deneyleri" ders malzemelerini hangi amaçla kullandınız?

- ☐ Laboratuvara (deneylere) hazırlık
- ☐ Laboratuvar (deney) tekrarı
- ☐ Hem deneylere hazırlık hem de deney tekrarı
- ☐ Diğer:____

  ____

15. ODTÜ nün Açık Ders Malzemeleri portalında (ocw.metu.edu.tr) bulunan "Genel Kimya Laboratuvarı Deneyleri'nin hangi uygulamalarını kullandınız?

- ☐ Sadece deney videolarını
- ☐ Sadece sanal deneyleri
- ☐ Hem deney videolarını hem de sanal deneyleri

16. ODTÜ nün Açık Ders Malzemeleri portalında (ocw.metu.edu.tr) bulunan "Genel Kimya Laboratuvarı Deneyleri'nin size katkısı olduğunu düşünüyor musunuz?

- ☐ Evet
- ☐ Hayır

17. Eğer 16. Soruya cevabınız evet ise size nasıl katkı ya da katkıları olduğunu düşünüyorsunuz? Birden fazla seçenek işaretleyebilirsiniz.

- ☐ Laboratuvar deneylerini verimli yapmama yardımcı oldu
- ☐ Laboratuvarda deneylere ayırdığım süreyi kısalttı
- ☐ Deneyleri anlamama yardımcı oldu
- ☐ Laboratuvar asistanlarına daha az soru sordum
- ☐ Notumu yükseltmemi sağladı

☐ Diğer:

____

____

18. Sizce ODTÜ nün Açık Ders Malzemeleri portalında (ocw.metu.edu.tr) bulunan "Genel Kimya Laboratuvarı Deneyleri" ders malzemelerinin sizin için sağladığı avantaj(lar) nelerdir? Lütfen belirtiniz.

____

____

____

19. Sizce ODTÜ nün Açık Ders Malzemeleri portalında (ocw.metu.edu.tr) bulunan "Genel Kimya Laboratuvarı Deneyleri" ders malzemelerinin (deney videoları, sanal deneyler) iyileştirilmesi gereken yönleri nelerdir?

____

____

APPENDIX B

INTERVIEW PROTOCOL FOR STUDENTS

Araştırma Sorusu: Açık Ders Malzemelerini Genel Kimya laboratuvar dersi kapsamında kullanımının ve etkinliğinin incelenmesi.

Görüşülen Kişi : ……………………………………

Görüşmeyi yapan : ……………………………………

Tarih & Saat : …..…/…..…/ 2014 / ..… : …...

Görüşme Süresi : ………………............................

Merhaba,

Adım Seçil Tısoğlu, ODTÜ Bilgisayar ve Öğretim Teknolojileri Eğitimi Lisansüstü programında hem araştırma görevlisiyim hem de doktora öğrencisiyim. Bu çalışmanın amacı öğrencilerin açık ders kaynaklarını kullanımı konusundaki algılarını ve deneyimlerini ortaya çıkarmaktır.

Öncelikle bu çalışmamda görüşlerinizi benimle paylaşmayı kabul ettiğiniz için teşekkür ediyorum. Bu konudaki kişisel deneyimleriniz, görüş ve düşünceleriniz araştırmam için büyük önem taşımaktadır. Bu görüşme sadece araştırma amaçlı kullanılacak olup veriler bilimsel çalışmalarda ve tezimde kullanılacaktır. Kişisel bilgileriniz hiçbir şekilde kullanılmayacaktır. Bilgileri sonradan hatırlayabilmek için izin verirseniz görüşmeyi kaydetmek istiyorum. Eğer sakıncası yoksa görüşmeye başlayabiliriz. Çalışmaya katıldığınız için teşekkür ederim.

1. Kaç yaşındasınız?
2. Hangi Bölümdesiniz?
3. Kaçıncı sınıfsınız?
4. Genel Kimya dersini kaçıncı kez alıyorsunuz?
5. Genel Kimya Laboratuvarında toplam kaç deney yaptınız?

---

1. Kimya dersi kapsamında kullanılan OCW (Açık Ders Kaynakları) hakkında bilgi verilmişti. Bu ders malzemelerini kullandınız mı?

- Evet ise;
    - I. Ne sıklıkla kullandınız?
    - II. Ne zaman kullandınız?
        - i. Ders öncesi
        - ii. Ders sonrası
    - III. Hangi formattaki uygulamayı kullandınız?
        - i. Video
        - ii. Simülasyon
        - iii. Her ikisi de
    - IV. Hangi deneyler için hangi formatı kullandınız?

    Deneyler: Introductory to Lab Technics, The Law of Definite Proportions, Compounds of Calcium and Determination of Salt Content of Tap Water, Preparation and Analysis of Potassium Trioxalatoferrate (III) trihydrate, Enthalpy of Formation, The Estimation of Avogadro's Number

2. Neden Açık Ders Malzemeleri sistemini kullandınız?
    a. Kullanma motivasyonunuzu etkileyen unsurlar neler? Hangi faktörler bu materyalleri kullanmanızı etkiledi?

b. Bu materyalleri kullanmadaki en önemli nedeniniz nedir? Bu materyalleri kullanmaya neden devam ettiniz? Ya da etmediniz?

3. Neden Açık Ders Malzemeleri sistemini kullanmadınız?
    a. Bu sistemi kullanmanızı engelleyen unsurlar nelerdir?
    b. Sistemi kullanmadığınız haftalarda materyallerle ilgili sıkıntınız nelerdir?

---

4. Materyallerin labdaki performansınıza etkisi oldu mu?
    a. Eğer olduysa nasıl bir etkisi olduğundan bahseder misiniz?
        i. kimyasalların tanınması / kullanımı, deney prosedürünün uygulanması (deneyi erken bitirme)
        ii. deneyi anlama, yorumlama, hatırlama
        iii. deney surecine uyum, memnuniyet, duyuşsal süreçler
        iv. akademik basari (quizler ve lab notları)
5. Materyallerden istediğiniz verimi alabildiniz mi?
    a. Bu dersten beklentiniz/ ihtiyacınız nedir?
    b. Bu materyaller ders kapsamındaki ihtiyacınızı karşılamada yeterli oldu mu?
    c. Materyallerin derse yardımcı olma konusunda bir etkisi var mı?
6. Materyalleri kullanırken yaşadığınız deneyimlerden bahseder misiniz? (Ek soru: Materyallerin kalitesini genel olarak nasıl değerlendiriyorsunuz?)
    a. Videoyu nasıl değerlendiriyorsunuz? (Süresi, konu anlatımı, konu kapsamı, anlaşılabilirliği, teknik özellikleri, güncelliği, kimyasalların kullanımı)
    b. Simülasyonu nasıl değerlendiriyorsunuz? (Süresi, konu anlatımı, konu kapsamı, anlaşılabilirliği, teknik özellikleri, güncelliği, kimyasalların kullanımı, yaş grubuna uygunluğu)
    c. Bu materyallerin konu kapsamı/içeriği sizce yeterli mi?

        i. Değilse hangi unsurların materyal içeriğine eklenmesini istersiniz?

    d. Bu materyallerde bir değerlendirme sistemi olmasını ister miydiniz? (Quiz ya da sınav gibi değerlendirme unsurları)

        i. Geri dönüt sistemi olmasını ister misiniz?

7. Materyalleri kullanırken kullanırken karşılaştığınız sorunlar nelerdir?
8. Sizce bu materyaller, öğrencilere faydalı olması açısından nasıl geliştirilebilir?
    a. Materyallerin kalitesi
    b. Video ve simülasyonların içeriği
    c. Konu anlatımı
    d. Deneylerin gerçeğe yakınlığı
    e. Teknik özellikleri

---

9. Derse gelmeden önce nasıl hazırlanıyorsunuz? Hangi kaynakları kullanıyorsunuz?
    a. Lab kitabı ve bu sistemi karşılaştırdığınızda hangisinin daha yararlı olduğunu düşünüyorsunuz? (Herhangi biri mi, yoksa ikisi de mi?)
10. Ders ortamındaki deneyimlerinizden bahseder misiniz?
    a. Konu anlatım surecini nasıl değerlendiriyorsunuz?
    b. Deney yapma surecini nasıl değerlendiriyorsunuz? Bu süreçte karşılaştığınız herhangi bir problem oldu mu?
    c. Ders performans değerlendirme sureci hakkında ne düşünüyorsunuz? (Quizler ve raporlar)
11. Genel Kimya laboratuvar dersi deneyimlerinizden yola çıkarak bu dersin geliştirilmesine yönelik önerileriniz nelerdir?
    a. Sizce bu dersin işlenişi nasıl değiştirilebilir? (Ek soru: Ya da ders sisteminin bu haliyle işlenişi yeterli mi?)

   b. Materyallerin ders içerisinde su anki haliyle kullanımı sizin için yeterli mi?
   c. Bu materyaller lab dersi kapsamında daha farklı kullanılabilir mi? (Ek soru: Materyaller ders surecine nasıl entegre edilebilir?)

12. Bu materyaller, sizce formal eğitimin yerini alabilir mi yoksa formal eğitim sistemine destek olarak mı kullanılmalı?
    a. Bu materyaller formal eğitime nasıl bir destek sağlıyor?
    b. Materyallerin su anki kullanımı isteğe bağlı, bu kullanım durumunu nasıl değerlendiriyorsunuz? Kullanım zorunlu hale getirilmeli mi?

---

13. Materyalleri ilk ne zaman duydunuz?
    a. Materyallerin yeterince duyurulduğunu düşünüyor musunuz?
    b. Materyal kullanımının yeterince desteklendiğini düşünüyor musunuz?
    c. Bolumun bu konudaki rolünü nasıl değerlendiriyorsunuz?
    d. Ders hocalarının ve asistanlarının bu konudaki rolünü nasıl değerlendiriyorsunuz?
14. Bu materyalleri kullanmak için ne tür teşvik unsurları olmasını istersiniz?
    a. Maille bilgilendirme
    b. Broşürle/afişle bilgilendirme
    c. Notlandırmada ek puan kazanma
    d. Ders hocalarının duyuru yapması
    e. Syllabus a açıklama ekleme
15. Bu materyallerin laboratuvar dersleri için yararlı olduğunu düşünüyor musunuz?
16. Bu materyallerin laboratuvar dersleri için gerekli olduğunu düşünüyor musunuz?
17. Başka bir üniversitenin/kuruluşun OCW portalını kullandınız mı? (MIT, Stanford, Berkeley etc.)
18. Bu materyalleri seçerken dikkat ettiğiniz unsurlar nelerdir?

a. Kolay erişim
b. Konu anlatımı
c. İhtiyaç
d. Güvenilir kaynak

19. Başka bir ders için OCW kullandınız mı?
    a. Hangi üniversitenin portalını kullandınız?
    b. Hangi materyalleri kullandınız? (Yazı, video, simülasyon)
    c. Neden bu portalı kullandınız?
    d. Bu materyalleri nasıl kullandınız? (İçeriği değiştirdiniz mi, başkalarıyla paylaştınız mı?)
    e. Bu materyalleri seçerken dikkat ettiğiniz unsurlar nelerdir?
        i. Kolay erişim
        ii. Konu anlatımı
        iii. İhtiyaç
        iv. Güvenilir kaynak
20. ODTU OCW sitesinde haberdar misiniz?
    a. Bu sistemi kullandınız mi? (Kullandıysanız hangi aralıklarla ve hangi dersler için kullandınız?)
    b. Kullanmadıysanız neden kullanmadınız? Kullanmanızı engelleyen unsurlar nelerdi?
21. Hangi dersler ya da konular için eğitim kaynağı sağlanmasını istersiniz?
    a. Hangi konular için bu materyallere ihtiyaç duyarsınız? Neden?
    b. Üniversitenin bu konudaki rolü hakkında ne düşünüyorsunuz?
22. Eklemek istediğiniz başka bir unsur var mı?

APPENDIX C

INTERVIEW PROTOCOL FOR TEACHING ASSISTANTS

Araştırma Sorusu: Açık Ders Malzemelerini Genel Kimya laboratuvar dersi kapsamında kullanımının ve etkinliğinin incelenmesi.

Görüşülen Kişi : ……………………………………

Görüşmeyi yapan : ……………………………………

Tarih & Saat : …..…/…..…/ 2014 / ..… : …...

Görüşme Süresi : ………………...........................

Merhaba,

Adım Seçil Tısoğlu, ODTÜ Bilgisayar ve Öğretim Teknolojileri Eğitimi Lisansüstü programında hem araştırma görevlisiyim hem de doktora öğrencisiyim. Bu çalışmanın amacı öğrencilerin açık ders kaynaklarını kullanımı konusundaki algılarını ve deneyimlerini ortaya çıkarmaktır.

Öncelikle bu çalışmamda görüşlerinizi benimle paylaşmayı kabul ettiğiniz için teşekkür ediyorum. Bu konudaki kişisel deneyimleriniz, görüş ve düşünceleriniz araştırmam için büyük önem taşımaktadır. Bu görüşme sadece araştırma amaçlı kullanılacak olup veriler bilimsel çalışmalarda ve tezimde kullanılacaktır. Kişisel bilgileriniz hiçbir şekilde kullanılmayacaktır. Bilgileri sonradan hatırlayabilmek için izin verirseniz görüşmeyi kaydetmek istiyorum. Eğer sakıncası yoksa görüşmeye başlayabiliriz. Çalışmaya katıldığınız için teşekkür ederim.

---

1. Kaç yaşındasınız?
2. Asistanlıkta kaçıncı yılınız?
3. Genel Kimya laboratuvar dersini kaçıncı defa veriyorsunuz?

---

4. Kimya laboratuvar dersleri kapsamında kullanılan Açık Ders Kaynaklarıyla (OCW) ilgili bir bilginiz var mı / haberdar mısınız?
5. Kimya laboratuvar dersleri kapsamında kullanılan Açık Ders Kaynaklarını (OCW) daha önce kullandınız mı?

- Evet ise;
    - V. Ne sıklıkla kullandınız?
    - VI. Ne zaman kullandınız?
        - iii. Ders öncesi
        - iv. Ders sonrası
    - VII. Hangi formattaki uygulamayı kullandınız?
        - iv. Video
        - v. Simülasyon
        - vi. Her ikisi de

6. Neden Açık Ders Malzemeleri sistemini kullandınız?
    a. Kullanma motivasyonunuzu etkileyen unsurlar neler? Hangi faktörler bu materyalleri kullanmanızı etkiledi?
    b. Bu materyalleri kullanmadaki en önemli nedeniniz nedir? Bu materyalleri kullanmaya neden devam ettiniz? Ya da etmediniz?
7. Neden Açık Ders Malzemeleri sistemini kullanmadınız?
    a. Bu sistemi kullanmanızı engelleyen unsurlar nelerdir?
    b. Sistemi kullanmadığınız haftalarda materyallerle ilgili sıkıntınız nelerdir?

---

8. Sizce kimya laboratuvar dersleri kapsamında kullanılan Açık Ders kaynaklarının öğrencilerin ders içi performansına etkisi var midir? (Ek soru: Bu durumu gözlemleme şansınız oldu mu?)
    a. kimyasalların tanınması / kullanımı, deney prosedürünün uygulanması (deneyi erken bitirme)
    b. deneyi anlama, yorumlama, hatırlama
    c. deney surecine uyum, memnuniyet, duyussal süreçler
    d. akademik basari (quizler ve lab notları)
9. Sizce Metalürji ve Maden grubu öğrencileri arasında deneyin uygulanması ve laboratuvar performansları açısından bir farklılık var mı?
10. Öğrencilerin Açık Ders Malzemelerini kullanmalarının sizin laboratuvar performansınıza etkisi herhangi bir katkısı oldu mu?
    a. deneyi anlama, yorumlama, hatırlama
    b. deney surecine uyum, memnuniyet, duyussal süreçler
    c. öğretim tekniği, öğretim sureci ve deneyimleri
11. Materyallerden istediğiniz verimi alabildiniz mi?
    a. Bu dersin amacı ve öğrencilerden beklentileriniz nelerdir?
    b. Bu materyaller ders kapsamındaki ihtiyacınızı karşılamada yeterli oldu mu?
    c. Materyallerin derse yardımcı olma konusunda bir etkisi var mı?
12. Materyalleri kullanırken yasadığınız deneyimlerden bahseder misiniz? (Ek soru: Materyallerin kalitesini genel olarak nasıl değerlendiriyorsunuz?)
    a. Videoyu nasıl değerlendiriyorsunuz? (Süresi, konu anlatımı, konu kapsamı, anlaşılabilirliği, teknik özellikleri, güncelliği, kimyasalların kullanımı)
    b. Simülasyonu nasıl değerlendiriyorsunuz? (Süresi, konu anlatımı, konu kapsamı, anlaşılabilirliği, teknik özellikleri, güncelliği, kimyasalların kullanımı, yaş grubuna uygunluğu)
    c. Bu materyallerin konu kapsamı/içeriği sizce yeterli mi?

        i. Değilse hangi unsurların materyal içeriğine eklenmesini istersiniz?

    d. Bu materyallerde bir değerlendirme sistemi olmasını ister miydiniz? (Quiz ya da sınav gibi değerlendirme unsurları)

        i. Geri dönüt sistemi olmasını ister misiniz?

    e. Laboratuvar kitabını nasıl değerlendiriyorsunuz? (Konu anlatımı, anlasilabilirligi, etkinliği)

13. Materyalleri kullanırken kullanırken karşılaştığınız sorunlar nelerdir?
14. Sizce bu materyaller, öğrencilere faydalı olması açısından nasıl geliştirilebilir?
    a. Materyallerin kalitesi
    b. Video ve simülasyonların içeriği
    c. Konu anlatımı
    d. Deneylerin gerçeğe yakınlığı
    e. Teknik özellikleri

---

15. Ders ortamındaki deneyimlerinizden bahseder misiniz?
    a. Konu anlatım surecinizi nasıl değerlendiriyorsunuz?
    b. Öğrencilerin deney yapma sürecini nasıl değerlendiriyorsunuz? Bu süreçte karşılaştığınız herhangi bir problem oldu mu?
    c. Ders performans değerlendirme süreci hakkında ne düşünüyorsunuz? (Quizler ve raporlar)
16. Açık Ders Malzemelerinin kimya laboratuvar dersi kapsamında kullanımı ve entegrasyonu ile ilgili önerileriniz nelerdir? Sizce bu materyaller daha etkin nasıl kullanılabilir?
    a. Sizce bu dersin işlenişi nasıl değiştirilebilir? (Ek soru: Ya da ders sisteminin bu haliyle işlenişi yeterli mi?)
    b. Materyallerin ders içerisinde su anki haliyle kullanımı sizin için yeterli mi?

c. Bu materyaller lab dersi kapsamında daha farklı kullanılabilir mi? (Ek soru: Materyaller ders sürecine nasıl entegre edilebilir?)

17. Bu materyaller, sizce formal eğitimin yerini alabilir mi yoksa formal eğitim sistemine destek olarak mı kullanılmalı?
    a. Bu materyaller formal eğitime nasıl bir destek sağlıyor?
    b. Materyallerin su anki kullanımı isteğe bağlı, bu kullanım durumunu nasıl değerlendiriyorsunuz? Kullanım zorunlu hale getirilmeli mi?
18. Bu materyallerin laboratuvar dersleri için yararlı olduğunu düşünüyor musunuz?
19. Bu materyallerin laboratuvar dersleri için gerekli olduğunu düşünüyor musunuz?

---

20. Materyalleri ilk ne zaman duydunuz?
    a. Materyallerin yeterince duyurulduğunu düşünüyor musunuz?
    b. Materyal kullanımının yeterince desteklendiğini düşünüyor musunuz?
        i. Desteklenmiyorsa, bu konuda hangi problemlerin öne çıktığını düşünüyorsunuz?
    c. Bölümün bu materyallerin kullanımı ve sürdürülebilirliği konusundaki politikasını nasıl değerlendiriyorsunuz?
    d. Ders hocalarının ve sizin bu konudaki rolünüzü nasıl değerlendiriyorsunuz?
21. Başka bir üniversitenin/kuruluşun OCW portalını kullandınız mı? (MIT, Stanford, Berkeley etc.)
22. Başka bir ders için OCW kullandınız mı?
    a. Hangi üniversitenin portalını kullandınız?
    b. Hangi materyalleri kullandınız? (Yazı, video, simülasyon)
    c. Neden bu portalı kullandınız?
    d. Bu materyalleri nasıl kullandınız? (İçeriği değiştirdiniz mi, başkalarıyla paylaştınız mı?)

e. Creative Commons lisansından haberdar misiniz?

23. ODTU OCW sitesinde haberdar misiniz?
    a. Bu sistemi kullandınız mi? (Kullandıysanız hangi aralıklarla ve hangi dersler için kullandınız?)
    b. Kullanmadıysanız neden kullanmadınız? Kullanmanızı engelleyen unsurlar nelerdi?
24. İleride bu materyalleri kendi dersleriniz kapsamında kullanmayı düşünüyor musunuz?
25. Eklemek istediğiniz başka bir unsur var mı?

APPENDIX D

INTERVIEW PROTOCOL FOR FACULTY MEMBERS

Araştırma Sorusu: Açık Ders Malzemelerini Genel Kimya laboratuvar dersi kapsamında kullanımının ve etkinliğinin incelenmesi.

Görüşülen Kişi : ……………………………………

Görüşmeyi yapan : ……………………………………

Tarih & Saat : …..…/…..…/ 2016 / ..… : …....

Görüşme Süresi : ………………..............................

Merhaba,

Adım Seçil Tısoğlu, ODTÜ Bilgisayar ve Öğretim Teknolojileri Eğitimi Lisansüstü programında hem araştırma görevlisiyim hem de doktora öğrencisiyim. Bu çalışmanın amacı öğrencilerin açık ders kaynaklarını kullanımı konusundaki algılarını ve deneyimlerini ortaya çıkarmaktır.

Öncelikle bu çalışmamda görüşlerinizi benimle paylaşmayı kabul ettiğiniz için teşekkür ediyorum. Bu konudaki kişisel deneyimleriniz, görüş ve düşünceleriniz araştırmam için büyük önem taşımaktadır. Bu görüşme sadece araştırma amaçlı kullanılacak olup veriler bilimsel çalışmalarda ve tezimde kullanılacaktır. Kişisel bilgileriniz hiçbir şekilde kullanılmayacaktır. Bilgileri sonradan hatırlayabilmek için izin verirseniz görüşmeyi kaydetmek istiyorum. Eğer sakıncası yoksa görüşmeye başlayabiliriz. Çalışmaya katıldığınız için teşekkür ederim.

---

1. Ne kadar süredir öğretim üyesi olarak görev yapıyorsunuz?
2. Hangi seviyede ders veriyorsunuz? (Lisans & YLisans)
3. Genel Kimya dersini veriyor musunuz, önceden verdiniz mi? (Ne kadar suredir Genel Kimya dersi veriyorsunuz?

---

4. Kendi dersiniz için hazırlanırken internet üzerindeki kaynaklardan yararlanıyor musunuz?
    a. Hangi kaynakları veya platformları kullandınız?
    b. Hangi materyalleri kullandınız? (Yazı, video, simülasyon)
    c. Derslerde kullanılan kaynak ve materyallerin paylaşımı konusundaki görüşleriniz nelerdir?
    d. Kendi ders materyallerinizi paylaşma konusundaki görüşleriniz nelerdir? (Ek soru: Paylaşmak istenmemesinin nedenleri nelerdir?)
    e. Creative Commons lisansından haberdar misiniz?
5. ODTÜ Açık Ders Kaynaklarıyla (OCW) ilgili bir bilginiz var mı / haberdar mısınız?
    a. Genel Kimya laboratuvar dersleri kapsamında kullanılan Açık Ders Kaynaklarıyla (OCW) ilgili bir bilginiz var mı / haberdar mısınız? (7,8,9. soru bağlayıcısı)
6. ODTÜ Açık Ders Kaynaklarını (OCW) kendi verdiğiniz dersiniz kapsamında kullandınız mı? (Dersinizi OCW kapsamında yayınladınız mı?)
    a. Evet ise;
        i. Ne zaman ve ne kadar süre ile kullandınız?
        ii. Hangi dersiniz için kullandınız?
    b. Hayır ise;
        i. Neden kullanmadınız?

---

7. Açık Ders Kaynaklarının (OCW) kullanımının yararlı olacağını düşünüyor musunuz?

   a. Genel Kimya laboratuvar dersinde kullanılan bu materyallerin yararlı olacağını düşünüyor musunuz?
      i. Sizin açınızdan
      ii. Öğrenciler açısından
      iii. Üniversite açısından
8. Sizce kimya laboratuvar dersleri kapsamında kullanılan Açık Ders kaynaklarının öğrencilerin ders içi performansına etkisi var midir?
   a. kimyasalların tanınması / kullanımı, deney prosedürünün uygulanması (deneyi erken bitirme)
   b. deneyi anlama, yorumlama, hatırlama
   c. deney surecine uyum, memnuniyet, duyussal süreçler
   d. akademik basari (quizler ve lab notları)
9. Kimya laboratuvar dersleri kapsamında kullanılan Açık Ders Malzemelerinin kalitesini genel olarak nasıl değerlendiriyorsunuz?
   a. Videoyu nasıl değerlendiriyorsunuz? (Süresi, konu anlatımı, konu kapsamı, anlaşılabilirliği, teknik özellikleri, güncelliği, kimyasalların kullanımı)
   b. Simülasyonu nasıl değerlendiriyorsunuz? (Süresi, konu anlatımı, konu kapsamı, anlaşılabilirliği, teknik özellikleri, güncelliği, kimyasalların kullanımı, yaş grubuna uygunluğu)
   c. Bu materyallerin konu kapsamı/içeriği sizce yeterli mi?
      i. Değilse hangi unsurların materyal içeriğine eklenmesini istersiniz?
   d. Bu materyallerde bir değerlendirme sistemi olmasını ister miydiniz? (Quiz ya da sınav gibi değerlendirme unsurları)
      i. Geri dönüt sistemi olmasını ister misiniz?
10. Bu materyaller, sizce formal eğitimin yerini alabilir mi yoksa formal eğitim sistemine destek olarak mı kullanılmalı?
   a. Bu materyaller formal eğitime nasıl bir destek sağlıyor?

    b. Materyallerin su anki kullanımı isteğe bağlı, bu kullanım durumunu nasıl değerlendiriyorsunuz? Kullanım zorunlu hale getirilmeli mi?

11. Bu materyallerin laboratuvar dersleri için yararlı olduğunu düşünüyor musunuz?
12. Bu materyallerin laboratuvar dersleri için gerekli olduğunu düşünüyor musunuz?

---

13. Verdiğiniz Genel Kimya dersi ile laboratuvar dersi arasındaki ilişkiyi nasıl değerlendiriyorsunuz?
    a. Laboratuvar dersinin işleniş sürecini nasıl değerlendiriyorsunuz? (Ek soru: Bu süreçte herhangi bir problem olduğunu düşünüyor musunuz?)
14. Açık Ders Malzemelerinin kimya laboratuvar dersi kapsamında kullanımı ve entegre edilmesi ile ilgili önerileriniz nelerdir?
    a. Sizce bu materyaller kimya dersi kapsamında daha etkin nasıl kullanılabilir? (Ya da kullanılmalı mi?)
    b. Benzer materyaller başka dersler kapsamında da kullanılabilir mi?
    c. Bu entegre ve kullanım süreciyle ilgili oluşabilecek problemler nelerdir?

---

15. Bu materyallerin kullanımı ve sürdürülebilirliği konusunda bölümünüzün politikası nedir?
    a. Sizce bu materyallerin kullanımı yeterince teşvik ediliyor mu?
        i. Materyallerin kullanımı ve teşvik edilmesine yönelik olası engeller nelerdir?
        ii. Bu materyallerin kullanımını arttırmak için ne tür teşvik unsurları uygulanabilir?

b. Sizin bu konudaki rolünüz nedir? (Ek soru: Materyalleri yeterince duyurduğunuzu veya teşvik ettiğiniz düşünüyor musunuz?)
c. Bölümünüzün bu konudaki rolü nedir?
d. Bu zamana kadar uygulanan herhangi bir yöntem ve uygulama var midir?

16. Eklemek istediğiniz başka bir durum var mı?

APPENDIX E

OBSERVATION PROTOCOL

Observational Fieldnotes 3 - Course Environment & Teaching and Learning Activities

Setting: General Chemistry Laboratory

Observer: Researcher

Role of the Observer: Observer of the activities, environment

Observation Group: METE (Students & TAs)

Time: 08.40 a.m. – 11.30 a.m., March 26, 2014 (Sem1/Exp 3)

Teaching Process		
Description of the process	**Reflective Notes**	**Checklist***
What kind of teaching method did assistants use? How much time did TAs spend for theory and experimentation process? How were the students distributed for the teaching process?		

Which resources did TAs used during the teaching process				
		Yes	**No**	**Frequency**
How was the interaction between the students and teachers?	Did teaching assistants asked questions in the teaching process?			
	Did students ask any questions during the teaching processes?			
	What kind of questions did they ask?	NA	NA	NA
Experimentation Process				
Description of the process	**Reflective Notes**	**Checklist**		
		Yes	**No**	**Frequency**
How were the participants' behaviors and feelings during the class?	Did TAs students asked questions about the process?			
	What kind of questions did they asked?	NA	NA	
	Did TAs behave as a guide or resource person?			
	Did they seem comfortable of relieved while doing the experiment or using the materials and chemicals?			

	Did they feel distracted or self-reliant while doing the experiment or using the materials and chemicals?			
	How was the interaction between group members during the experimentation process?	NA	NA	NA
	Did the participants worked collaboratively of by themselves? (Freeloaders?)			
	Did students finish the experiment earlier?			
	How did they prepare their reports after the classroom?	NA	NA	NA
OER Evaluation	**Reflective Notes**	**Checklist**		
		Yes	**No**	**Frequency**
	Did TAs inform the students about the resources?			
	Did they ask the students' use of resources or how they prepared?			
	Video	**Simulation**		
How did they evaluate the quality of the resources? (Mini-talks)				
Were they satisfied to use the resources before the class?				

* Checklist displayed the researcher's final thoughts about the general evaluation of each criterion based on the reflective notes and observations.

APPENDIX F

INFORMED CONSENT FORM

Bu çalışma ODTÜ Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü bünyesinde doktora öğrencisi Arş. Gör. Seçil Tısoğlu tarafından, Prof. Dr. Kürşat Çağıltay gözetiminde yapılmaktadır. Çalışmanın amacı Açık Eğitim Kaynaklarının kullanımının etkileyen faktörleri araştırmaktır. Çalışmadan elde edilecek bilgiler, Açık Ders Materyallerinin Kimya laboratuvar derslerinde kullanımı ve etkinliği ile ilgili veriler sunacaktır. Çalışmaya katılım tamamen gönüllüğe dayalıdır ve onayınız ile gerçekleşecektir. Herhangi bir rahatsız olma, sıkılma, isteksizlik vb. durumlarında anında çalışmadan çekilebilirsiniz. Çalışma süresince en az 1 araştırmacı size yardım etmek üzere yakınınızda bulunacaktır. Çalışma 2 kısımdan oluşup toplamda en fazla 1 saat sürecektir. İlk kısımda gözlem ikinci kısımda ise görüşme yapılacaktır.

Gözlem süresince yapılan deneyler ve uygulamalarla ilgili alınan notlar sadece bilimsel yayınlarda ve tezde kullanılacaktır. Herhangi bir kişisel bilgi paylaşılmayacaktır. Görüşme süresince ise sesiniz verilen bilgilerin hatırlanması amacı ile kayıt altına alınacak ve bu veriler kişisel bilgi verilmeden sadece bilimsel yayınlarda ve tezde kullanılacaktır.

Bu çalışma sırasında herhangi bir nedenden ötürü kendinizi rahatsız hissederseniz istediğiniz zaman uygulamayı yarım bırakmakta serbestsiniz. Bu çalışmaya katıldığınız/katılıma izin verdiğiniz için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü öğretim üyelerinden Prof. Dr. Kürşat Çağıltay ile (Tel:312 210 3683; E-posta:

kursat@metu.edu.tr) ya da araştırma görevlisi Seçil Tısoğlu (Tel:312 210 7519; E-Posta:tsecil@metu.edu.tr) ile iletişim kurabilirsiniz.

Bu çalışmaya tamamen gönüllü olarak katılıyor ve verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum.

İsim Soyad	Tarih	İmza
	----/----/-----	

APPENDIX G

CODING SCHEME

Conceptually Clustered Matrix: Use and Integration of resources (Adapted from Miles and Huberman, 1994)

	RQ1a			**RQ1b**		
Informants	Prep for the course	Motives to use	Barriers to use	Teaching Process	Experimentation Process	Assessment Process
Students	Approx. 30 min: use every resources (N=22) Approx. 30 min: use resources only (N=8) & use the laboratory book only (N=3) Less than 30 min: use laboratory book only (N=9) Observation: many students prepared only before the class through laboratory book	***Intrinsic*** ***To have prior knowledge (N=14)*** To know procedure of experiment (N=7) To see how to use equipment (N=4) ***Characteristic of the resources*** Visual environment (N=8) Quality of lab book: (N=7) Language opportunity: (N=5)	***Student-related*** Lack of interest: (N=8) Lack of time: (N=15) Forgot to use: (N=6) Level of experience: (N=2) ***Course-related*** Perceived value of the department: (N=2) Teaching tradition: (N=2) ***Resource-related***	***Teaching style*** Different teaching styles: (N=5) ***Interaction*** Lack of interaction between students and TAs: (N=7) Aims for the course: (N=3) Need for teaching process: (N=18) No need for teaching process: (N=3) Observation: students and teaching	***Result-oriented experience*** Teacher-directed experience: (N=6) ***Excessive number of questions*** Recall the procedure (N=8) ***External Factors*** Non-parallel main course and lab: (N=3)	***Pre-quizzes*** Quality of the questions: (N=5) Sequence of quizzes: (N=5) ***Reports*** Validity of evaluation: (N=3) Lack of interpretation: (N=3) Observation 1: the students wrote the reports together, mostly copy from each other Observation 2: some group

		Curiosity (N=5) ***Extrinsic*** Being informed (N=6) Social influence: (N=2) Improve grades: (N=6) Duration of experimentation: (N=7) ***Sustain to use*** Self-improvement: (N=17) Regular information: (N=3)	Possible poor effects on grades: (N=3) Poor fit with the purposes: (N=7) ***External factors*** Lack of information: (N=11) Social influence: (N=2)	assistants did not have much communication during teaching process. ***Integration of the resources into teaching process*** Change teaching process: (N=7) Keep the current one: (N=11)		members relied heavily on his/her partner's experience Observation 3: Hard to observe each student's performance on experimentation process for TAs ***Integration of the resources into assessment process*** Modify questions for resources: (N=6)
TAs (Observation)			***Student-related*** Lack of interest: (N=6) ***Course-related*** Teaching tradition: (N=3)	***Interaction*** Long teaching procedure: (N=3) Lack of assessment: (N=2) ***Integration of the resources into teaching process*** Change teaching process: (N=9)	***Result-oriented experience*** Teacher-directed experience: (N=4) ***Role of TAs*** Combine theory with experiment: (N=3) Observation: most of them were giving answers; desirable position was	***Pre-quizzes*** Quality of the questions: (N=3) Strategy for quality issue: question pool were created to standardize the questions Strategy for sequence issue: No common way was determined

				Keep the current one: (N=2)	guider or mentor. ***Excessive number of questions*** Lack of preparation: (N=4) Poor quality of the questions: (N=3) Excessive number of students: (N=5) ***External Factors*** Non-parallel main course and lab: (N=6) Frequency of lab: (N=3)	for the sequence of quizzes
TAs (Self-experience)	More than 30 min: use every resource (N=7) No use of resources: (N=4)	***Intrinsic*** Teaching practice: (N=8) Learn the process: (N=3) ***Sustain to use*** Self-improvement: (N=5) Recall: (N=2)	***Self-non-usage*** Level of experience: (N=4)	***Teaching method*** Teacher-directed experience: (N=2) ***Teaching style*** Different teaching style: (N=2) Quality of teaching: (N=2)		

Professors	N/A ***Integration of resources into system*** Flipped classroom approach: (N=3) Strategy: For some courses, they removed the teaching process to make students prepared for the course	N/A	N/A	***Teaching method*** Teacher-directed experience: (N=2) ***Teaching style*** Teaching style strategy: minimize the differences between teaching ***Integration of the resources into teaching process*** Flipped classroom approach: N=2 Keep the current one: (N=2)	***Result-oriented experience*** Teacher-directed experience: (N=3) ***External Factors*** Non-parallel main course and lab: (N=3)	

	RQ1c		
Informants	OER Culture	Department Support	Desired Practices
Students	Beware of OER: (N=27) ***Selection criteria*** Popularity: (N=6) Reliable source: (N=11) Scope of the content: (N=9) Parallel content: (N=6)	***System-related*** Lack of encouragement: (N=15) ***Organizational*** Lack of communication: (N=5)	***System-related*** Communication platforms: (N=3) ***Resource-related*** ***Advertisement*** Brochure-poster E-mail Recall by faculty Social media

	Beware of OCW: (N=8) ***Barriers to use OCW*** Lack of awareness: (N=28) Insufficient content: (N=13) Lack of interest: (N=5) Prejudices: (N=2) Traditional studying activities: (N=3)		Website announcements Presentation during class ***Encouragement*** Social influence Bonus point Popularity Mobile applications ***Organizational*** Provide a coordinator: (N=2) ***Institutional Practice*** Generalize sharing culture: (N=6) International marketing: (N=8) Broaden the resources: (N=30)
TAs (Observation)	***Barriers to use OCW*** Lack of interest	***Personal*** Adaptability for educational innovations: (N=6) ***System-related*** Attitude to course: (N=5) ***Resource-related*** Lack of encouragement: (N=7) ***Organizational*** Decision-making: (N=3)	***System-related*** Discipline based experiments: (N=2) Good interaction: (N=2) ***Resource-related*** ***Advertisement*** Social media Recall by faculty Presentation during class ***Institutional Practice*** International reputation: (N=2) Broaden the resources: (N=8)

TAs (Self-experience)	***User Culture*** Beware of OER: (N=11) Beware of OCW: (N=3) ***Academic Culture*** ***Openness*** Not familiar: (N=10)		
Professors	***Academic Culture*** Use of online resources: (N=3) ***Sharing Culture*** Reference concern: (N=2) No need: (N=2) Personal concern: (N=1) Academic concern: (N=2) Lack of time and organization: (N=4) ***Openness*** Not familiar: (N=2)	***Personal*** Academic concerns (N=3) ***System-related*** Attitude to course: (N=2) Teaching tradition: (N=3) Lack of communication: (N=2) ***Resource-related*** Lack of encouragement: (N=2) Adoption: (N=1) Quality of resources: (N=4) ***Organizational*** Lack of sustainable practices: (N=3) Financial support: (N=2)	***System-related*** Discipline based experiments: (N=2) Correspond the theory with lab: (N=2) ***Organizational*** Provide a coordinator: (N=2) Attend a working group: (N=1) Interdisciplinary approach: (N=1) ***Institutional Practice*** Generalize sharing culture: (N=2)

	RQ2				
Informants	Expectation from lab	Academic Outcome	Cognitive Outcome	Psychomotor Outcome	Affective Outcome
Students	***Affective*** Get higher grade (N=12) Enjoyment (N=2) ***Psychomotor*** Duration of experimentation (N=5) Practical Skills (N=6) ***Cognitive*** Have procedural knowledge (N=6) Interpretation (N=2) No particular aim or expectation: (N=10)	***No sufficient effect (N=21)*** Lack of correspondence with assessment: (N=16) ***Indirect effect*** Help to understand the content: (N=9) ***Positive effect*** Help to get higher grades: (N=15)	***Conceptual Knowledge*** Visual identification: (N=6) ***Procedural Knowledge*** Understand the procedure: (N=17) Recall the process: (N=19) Visualize the process: (N=11) Help to apply in practice: (N=6) ***Comprehension*** Lead to interpretation: (N=4) Meaningless experience: (N=6)	Technique in using equipment: (N=9) Safety instructions: (N=3) Duration of experimentation: (N=26) No effect on time: (N=6)	***Attitudes*** ***Quality of the resources:*** ***Videos Strong sides:*** Visual quality: (N=10) Teaching process: (N=7) Length: (N=23) ***Poor sides:*** Visual quality: (N=8) Teaching process: (N=3) Update: (N=19) ***Simulations Strong sides:*** Visual quality: (N=10) Enjoyable: (N=6) Practical application: (N=5) Step by step explanation: (N=5) ***Poor sides:*** Visual quality: (N=15)

					<u>Artificial environment:</u> (N=6) <u>Quality of teaching process:</u> (N=15) <u>Lack of user engagement:</u> (N=6) <u>Technical problems:</u> (N=10) <u>Lack of guidance:</u> (N=6) <u>Video vs simulation</u> ***Quality of laboratory book*** <u>Conceptual information:</u> (N=9) <u>Information for questions in quizzes:</u> (N=8) <u>Printed material:</u> (N=12) ***Benefits*** ***Comfortable process (N=17)*** <u>Feeling relieved:</u> (N=5) <u>Self-confidence:</u> (N=14) <u>Self-reliant:</u> (N=7)

					Preparations for the course Multiple practice opportunity: (N=7) Easier to understand: (N=12) ***Different learning experience (N=16)*** ***Language opportunity (N=7)*** ***Necessity*** Necessary: (N=12) No necessary but beneficial: (N=8) No necessary: (N=3)
TAs (Observation)		***Indirect effect*** Help to understand the content: (N=3) ***Group performances*** No difference: (N=6) METE was better: (N=5)	***Conceptual Knowledge*** Familiarization of characteristic of chemicals: (N=4) Prepare the mind for conceptual knowledge: (N=6)	Technique in using equipment: (N=4) Duration of experimentation: (N=5)	***Benefits*** Self-reliant: (N=4) Easier to understand: (N=2)

			Procedural Knowledge Understand the procedure: (N=6) Recall the process: (N=3) ***Comprehension*** Meaningless experience: (N=4)		
TAs (Self-experience)	***Cognitive*** Teaching experience (N=5)		***Procedural Knowledge*** Recall the experiments: (N=5)	Professional life: (N=1)	***Attitudes*** Quality of the resources ***Quality of the resources:*** ***Videos Strong sides:*** Visual quality: (N=6) Teaching process: (N=5) Length: (N=3) ***Poor sides:*** Language: (N=2) ***Simulations Strong sides:*** Visual quality: (N=3) Enjoyable: (N=2)

					Practical application: (N=2) ***Poor sides:*** Visual quality: (N=3) Quality of teaching process: (N=3) Technical problems: (N=4) ***Quality of laboratory book*** Quality of expressions: (N=5) Lack of visuals: (N=2) ***Benefits*** Feeling relieved: (N=3) Improve teaching practice: (N=6) Direct students: (N=4) ***Necessity*** Necessary: (N=2) No necessary but beneficial: (N=9)

Professors	***Expectation from students*** <u>Interpretation (Cognitive):</u> (N=3)		***Comprehension*** <u>Lack of critical thinking:</u> (N=2)		<u>No necessary but beneficial:</u> (N=3) <u>No necessary:</u> (N=1)

APPENDIX H

IRB APPROVAL

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

DUMLUPINAR BULVARI 06800
ÇANKAYA ANKARA/TURKEY
T: +90 312 210 22 91
F: +90 312 210 79 59
ueam@metu.edu.tr
www.ueam.metu.edu.tr

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

Sayı: 28620816/

28.02.2014

Gönderilen : Prof. Dr. Kürşat Çağıltay
Bilgisayar ve Öğretim Teknolojileri Eğitimi

Gönderen : Prof. Dr. Canan Özgen
IAK Başkanı

İlgi : Etik Onayı

Danışmanlığını yapmış olduğunuz Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü öğrencisi Seçil Tısoğlu'nun "Developing a Framework for the Use of Open Educational Resources within Science Laboratory Classes Context: A Case Study" isimli araştırması "İnsan Araştırmaları Komitesi'' tarafından uygun görülerek gerekli onay verilmiştir.

Bilgilerinize saygılarımla sunarım.

Etik Komite Onayı
Uygundur
28/02/2014

Prof.Dr. Canan Özgen
Uygulamalı Etik Araştırma Merkezi
(UEAM) Başkanı
ODTÜ 06531 ANKARA

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Tısoğlu, Seçil
Nationality: Turkish (TC)
Data and Place of Birth: 3 May 1987, Tarsus
Marital Status: Married
Phone: +90 505 806 61 27
E-mail: stisoglu@gmail.com

EDUCATION

Degree	Institution	Year of Graduation
Ph.D.	METU-Computer Education& Instructional Techonolgy	In progress
BS	Uludağ University-Computer Education& Instructional Technology (Hons)	2009
High School	Abdülkerim Bengi Anadolu High School, Tarsus	2005

WORK EXPERIENCE

Year	Place	Enrollment
2010-2017	METU-Computer Education& Instructional Technology	Research Assistant
2017-present	Kastamonu University-Computer Education&Instructional Technology	Research Assistant

FOREIGN LANGUAGES

English (Advanced Level)

PUBLICATIONS AND PRESENTATIONS

Tisoglu, S., & Kaya, K. Y. (2017). Proceedings from EDEN 2017. *Exploring the Use and Creation of a MOOC Environment: A Case Study*.

Tisoglu, S., Kaya, K. Y., & Cagiltay, K. (2016). Proceedings from OE Global 2016. *Exploring the Non-obligatory use of Open Educational Resources: A Case Study*

Kara, E., Esfer, S., Gulec, M., Tisoglu, S., & Kaya, S. K. (2016). Proceedings from ICITS 2016. *2003-2015 Yillari Arasinda Ogretim Teknolojileri Alaninda Yazilmis Doktora Tezlerinin Icerik Analizi*

Kaya, K. Y., Tisoglu, S., & Cicek, M. (2015). *Proceedings from AECT 2015*: Creating and Evaluating a Visual Progamming Course based on Experience of Students: A Case Study

Cicek, M., Kaya, K. Y., & Tisoglu, S. (2013). Proceedings from AECT 2013. The Reasons of Playing/not Playing Games on Facebook: University Students' Case

Tisoglu, S., Kaya, K. Y., & Cagiltay, K. (2013). Proceedings from ICITS 2013. *Examining the Village Institutions from the Aspect of Instructional Technology: Literature Review*

Kaya, K. Y., Tisoglu, S., Kankilic-Ucak, S. S., & Akman-Kadioglu, E. (2012). Proceedings from EDULEARN'12. *Perceptions of Prospective Information Technologies Teachers towards Fatih Project and its Components*

Kaya, K. Y., Tisoglu, S., Kankilic-Ucak, S. S., & Akman-Kadioglu, E. (2012). Proceedings from ICITS 2012. *Investigating Technological Components of Fatih Project: A Review of Literature*

Tisoglu, S., & Cagiltay, K. (2011). Proceedings from ICITS 2011. *Gender Differences in Game Preferences of Faculty of Education Students for Educational Game Design*

HOBBIES

Cycling, Travelling, Badminton, Tennis