

# The Impact of OER on Instructional Effectiveness: A Case Study

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This descriptive study aims to investigate the instructional effectiveness of Open Educational Resources (OER). It was conducted with 1196 university students who were enrolled in a general chemistry course with an experimental laboratory section. These students voluntarily used OER for their lab activities. Data were collected via a printed, 18-question survey. Results showed that about half of the students were aware of the OER, and half of these informed students used it. Nonetheless, four advantages of the OER were determined: preparation for topic in advance, facilitating learning, time saving, and improving grades

*Keywords:* Open educational resources, OER, OpenCourseWare, OCW, chemistry education

## INTRODUCTION

Advancements in technology and the possibilities they offer affect nearly all areas of modern daily life, especially the ways people think and learn. For instance, increased processing speed and data capacity, cloud computing and Web 2.0 technologies, and the number of mobile devices connected to broadband Internet have not only influenced learning habits but have started to shape educational approaches (Bonk, 2009; Kursun, 2011; OECD, 2007; White & Manton, 2011; Johnstone & Poulin, 2002). Challenges such as globalization, the need for life-long learning, and competition between educational institutions have forced schools and universities to review their systems and courses with respect to the changing needs of learners (Bonk, 2009; OECD, 2007; Johnstone & Poulin, 2002). The Internet offers a natural, intuitive way to share knowledge, and many institutions have been seeking online solutions to help both students and educators (Johnstone & Poulin, 2002). Making knowledge globally accessible through university-level course materials may help students learn their coursework better and encourage adults to seek and sustain life-long learning (OECD, 2007; Rhoads, Berdan, & Toven-Lindsey, 2013).

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According to Shumar, educational systems have become a marketplace where institutions sell knowledge to students (as cited by Barrett et al., 2009). While many educational institutions actively pursue paying students to fill courses, in 2000, the faculty at MIT proposed the OpenCourseWare (OCW) project to disseminate its educational materials over the Internet (MIT, 2014; Carson, 2009). MIT defines OCW as “a free and open digital publication of high quality university-level educational materials—often including syllabi, lecture notes, assignments, and exams—organized as courses” (MIT, 2014). The mission of OCW is to provide free materials to educators and learners under open licenses, outside of certificate or degree programs. The MIT OCW published 50 courses in 2002 (MIT, 2014), with more than 2150 available to over 125 million visitors by August 2014 (MIT, 2014). System usage statistics readily indicate both the importance and availability of OCW systems.

The need to support using and sharing online resources extends outside educational institutions. High quality education seems to be key for maintaining peace, establishing sustainable social and economic developments, and encouraging intercultural dialogue, on which Open Educational Resources (OERs) are believed to have strategic influence (UNESCO, 2013). In 2002, UNESCO organized the First Global OER Forum in order to investigate both the possibility of universal access to high quality education (UNESCO, 2013) and the impact of OCW on higher education in developing countries (Johnstone, 2005). The MIT OCW project and similar projects of other U.S. universities were presented and discussed throughout the forum, and the very premise of Open Educational Resources was one of many outcomes (Johnstone, 2005). As a result of the exponential growth of free and accessible information, the OER movement is becoming more common around the world (Rhoads, Berdan, & Toven-Lindsey, 2013). OER materials are regularly published with an open, creative common license, which allows users to duplicate, edit, and reuse materials in alignment with defined educational purposes. Another distinctive feature of these materials is educational intent, even though they might have not been published with that aim originally (White & Manton, 2011).

Despite a slight difference between the terms OCW and OER, they are generally used interchangeably. On one hand, both OCW and OER materials are offered to everyone for no fee. On the other hand, OCW materials are organized as courses, while OERs consist of any size or type of digital learning materials. It could be said that each OCW is an OER, but not every OER is an OCW (Terrell & Caudill, 2011). In other words, OCW can be considered an organized type of OER.

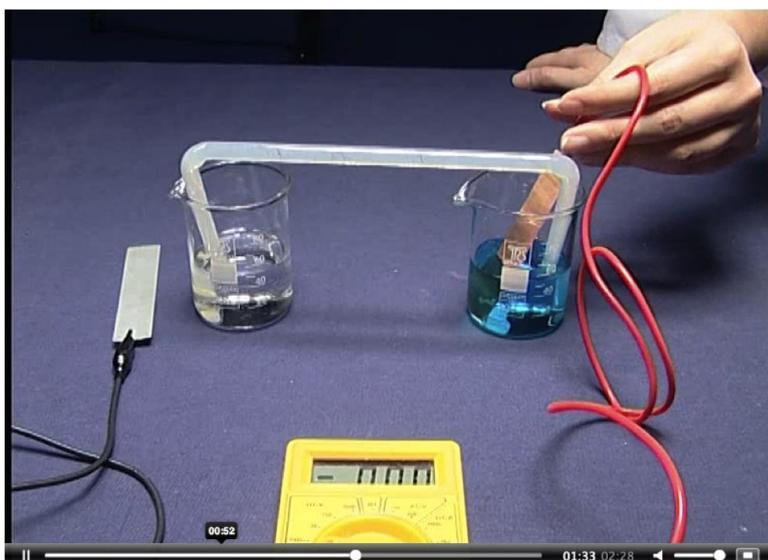
Many Turkish scholars, like many participants in the worldwide OER movement, have been sharing course materials with other learners via personal web sites since universities in Turkey gained access to the Internet in 1993 (Wolcott & Cagiltay, 2000). Nevertheless, these were individual initiatives, rather than an organized, nationwide course material sharing community. The Turkish Academy of Sciences (TUBA) launched an OCW project in 2007 where delegates from 24 universities and research institutes gathered to discuss the status, future, and benefits of OCW. Following this meeting, TUBA held a national OCW consortium (TUBA, 2013). Although 61 universities endorsed the program, only eight produced institutional

### **State of the literature**

- Open Educational Resources were offered by MIT in 2000 to help learners and make knowledge reachable to everyone.
- OER has been popular to all over the world and keep evolving then
- Effectiveness of OER and its acceptability by learners are the least reached topics.

### **Contribution of this paper to the literature**

- This is an effectiveness study of Turkey's biggest OER project.
- Although open educational materials are freely available to learners, their utilization is rather low. OER should be promoted to target group via several different ways, especially with social media.
- Videos with clear narration and subtitle options are the most demanding OER from students.

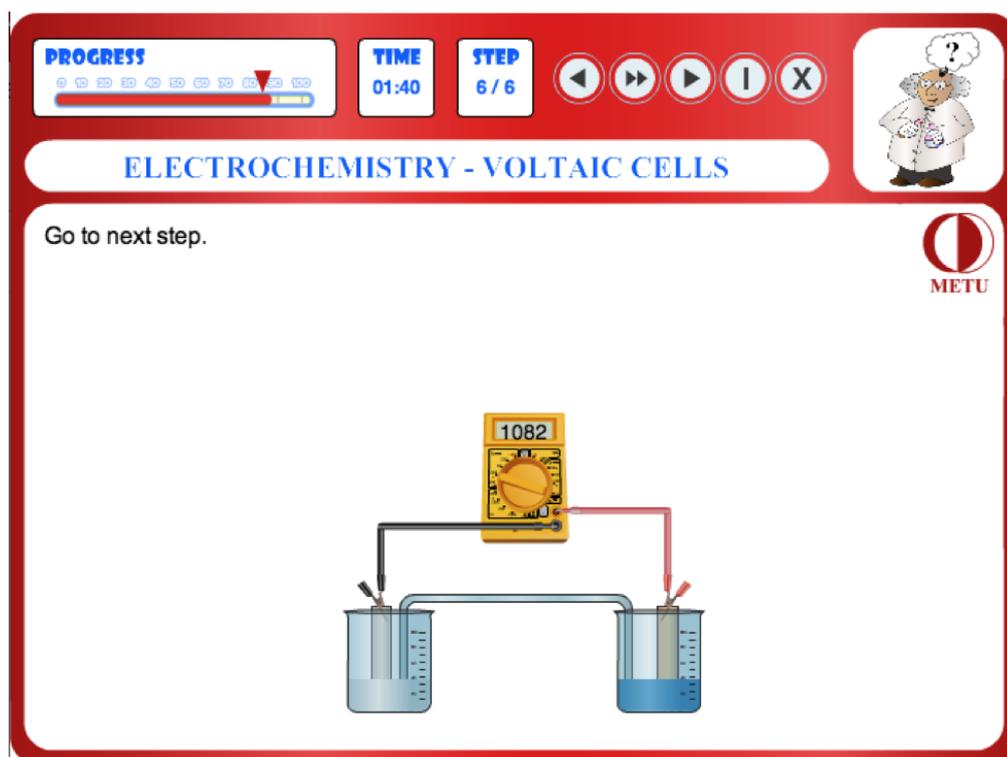


**Figure 1.** A screenshot of a video recorded chemistry experiment

OCW sites. Among these eight universities, Middle East Technical University (METU) currently offers the greatest number of courses. Its OCW project officially began on April 16, 2008 (Cagiltay & Kursun, 2011). As of 2014, 125 open courses from 33 departments and five faculties have been posted and shared. METU faculty members have published videos, seminars, and e-books. Since its launch, the portal has been visited by 277,551 individual visitors accessing 379,807 pages. According to a Google Analytics report, 17,711 visits were made between March 1 and March 31, 2014, by 13,959 individual users accessing 80,422 pages. Although some materials are in Turkish, most are in English, the official instructional language of METU. Therefore, the METU OCW is usable not only by students in Turkey but also from other countries. An analysis of viewers showed that almost half of the visitors access the site from outside Turkey. During the same period in March 2014, the METU OCW had 1,207 visitors from the USA, 894 from India, 429 from the Philippines, 373 from Indonesia, 257 from the UK, 248 from Pakistan, 157 from Malaysia, 134 from Germany, and 123 from Egypt.

### **General chemistry laboratory experiments as OER**

METU has continuously improved both the hardware and software of the OCW project, particularly through the implementation of new applications; one of which is General Chemistry Laboratory Experiments. General Chemistry Laboratory is a part of the General Chemistry courses at METU, which are must for the majority of the undergraduate students of different colleges. Students enrolled to General Chemistry Course should attend laboratories and conduct experiments within a limited time due to large number of students enrolled to course. Students are required to study each experiment before the lab hours in order to conduct the experiment on time. To support students' preparedness, the Department of Chemistry and Instructional Technology Support Office (ITS) collaborated that each General Chemistry Laboratory experiment was recorded and published with materials, equipment, and steps in OER format in Fall 2011 (see Figure 1). Moreover, interactive virtual experiments (see Figure 2) were simultaneously published in Adobe Flash to increase interaction between the material and the learner. These all materials are supplementary to General Chemistry Laboratory content and the use of the OER was not mandatory.



**Figure 2.** A screenshot of an interactive virtual chemistry experiment.

**Table 1. Participant demographic information**

Faculty	Female (N)	Male (N)	Total (N)
Arts and Sciences	154	95	249
Education	65	28	93
Engineering	240	614	854
<b>Total</b>	<b>459</b>	<b>737</b>	<b>1196</b>

The METU Chemistry Lab OER videos received a Video and Multimedia Award for OpenCourseWare Excellence from the OCW Consortium in 2011. Videos and interactive virtual experiments are available at <http://ocw.metu.edu.tr/course/view.php?id=99>.

### Research focus

The purpose of this study was to examine the instructional effectiveness of the Chemistry Lab OER. While these resources appear to be helpful, the extent of their instructional impact has not yet been studied widely. The literature includes few studies on the effectiveness of OCW or OER systems. The most prominent research was conducted by a group at Oxford University in 2011, examining lecturers' and students' use of OER (Masterman & Wild, 2011). In addition, Hatakka and Lagsten (2012) investigated students' use of Internet resources in 2012. Although the focus of their study was not OER, it remains a valuable explanation of students' use of online resources. The present study is an attempt to reveal how students voluntarily use and are affected by one particular OER.

## METHODOLOGY

### Sample

This descriptive study was conducted with 1196 freshmen enrolled in a General Chemistry course held in Fall 2011. Students were from three different colleges of METU: 854 from College of Engineering, 249 from College of Arts and Sciences, and 93 from College of Education (see Table 1). Over half ( $n = 737$ ) of the students were male, and the rest were female ( $n = 459$ ).

### Instrument and procedures

Data were collected via a printed survey developed by researchers involved in the present study and reviewed by five experts. Each expert was a faculty member at a state university and an experienced instructional designer. The questionnaire was re-organized after compiling expert opinions. The final survey consisted of 18 questions: eight demographic, seven multiple choice, and three open-ended questions about how the students used and benefitted from the Chemistry Lab OER.

The course includes a four-hour theoretical lecture and two-hour experimental laboratory each week. The purpose of the course is to provide theoretical knowledge on basic principles of chemistry, properties and states of matter, electron configuration, and periodic properties of atoms, chemical bonds, and molecular structures. The lab sessions include experiments related to basic chemistry principles.

Two kinds of OER exist for the chemistry course's experimental lab sessions: videos and interactive virtual chemistry experiments. These resources were prepared through collaboration between the Department of Chemistry and the Instructional Technology Support Office (ITS). While the Department of Chemistry organized the content and conducted experiments, ITS recorded, edited, and narrated the videos. Furthermore, ITS developed the interactive virtual lab experiments in Adobe Flash. Both videos and virtual experiments were controlled and tested by the Department of Chemistry before being uploaded to the portal.

The Chemistry Lab OER was announced to students via several ways. A brochure and email about the virtual experiments and videos were distributed to students, and teaching assistants announced the system in classes. The use of the OER was not mandatory because the researchers preferred to observe voluntary use.

After the initial informative sessions, students were not reminded of the system for the rest of the semester. Questionnaires were distributed by the Department of Chemistry prior to the final exam to gather data from all of the students who attended the experimental lab sessions. Answers were recorded and entered into a statistical analysis program. Four questions were open-ended and required additional analyses; their answers were re-written and grouped under main themes.

## RESULTS

### Awareness about METU OCW and Chemistry OER

According to the results, 46.49% ( $n = 556$ ) of students stated they were aware of the METU OpenCourseWare system, while 53.51% ( $n = 641$ ) indicated they were not. Moreover, of the students who were aware of the system, 55.58% ( $n = 309/556$ ) used the experimental chemistry lab OER each week properly, while the rest (44.42%;  $n = 247/556$ ) did not. One question asked why students did not use the experimental chemistry lab OER. The responses were as follows: "they were not informed" ( $n = 363$ ), "they did not need to" ( $n = 129$ ), "lab flyers were quite enough" ( $n = 31$ ), "there was not enough time" ( $n = 16$ ), and "other reasons" ( $n = 57$ ).

Although students were informed at the beginning of the semester via multiple channels, some still reported lack of awareness, which demonstrated that students are in need of being continuously reminded about the existence and benefits of OER materials.

### **Use of chemistry OER**

The analysis of data revealed that 309 students actively used the system. Of these 309 students, 236 (76.4%) were from Engineering, 46 (14.9%) from Arts and Sciences, and 27 (8.7%) from Education. When the students who used the Chemistry OER were compared to the total number of students in their field who participated in the study, the highest percentage of use was in Education at 29.03% (27/93). Engineering took second place at 27.63% (236/854), followed by Arts and Sciences with 18.47% (46/249).

One question asked how or for what purposes the system was used by students. Students stated that they used it in order to “get ready for chemistry experiments” (n = 257), “get ready for and to practice chemistry experiments” (n = 21) and “repeat chemistry experiments” (n = 10). Another question was asked to determine sequences of system usage. A total of 118 students stated that they used the system occasionally before the chemistry lab, while 91 logged in to the system before each lab. Another 43 students used the system only once, 14 before and after each lab, 11 occasionally before and after the lab, 6 after each lab, and 3 occasionally after the lab. The results confirmed that students mostly used the resources before lab sessions to get ready for experiments.

The system had two applications: experiment videos and interactive virtual experiments. Experiment videos were prepared to show equipment, steps, and outcomes, offering no interactive components. Virtual experiments, on the other hand, demonstrated equipment, steps, and outcomes by allowing students to try or repeat the experiment. Out of 309 students, 232 accessed the experiment videos, while 15 used only virtual experiments and 41 used both. Many students preferred watching videos to conducting virtual experiments, possibly because of established habits of observing a task instead of doing it. Another explanation may be that conducting virtual experiments takes more time than watching videos.

Further, 268 of 309 students indicated that the system had a positive effect on their lab grades. A total of 168 students stated that the chemistry OER helped them better understand the laboratory activities and experiments, while 126 students reported that the system had no effect on their understanding of experiments. Moreover, 29 students stated that the system had no effect on either their grades or understanding. Overall, most of the students who used the OER agreed that the system had a positive effect.

### **Advantages of the chemistry OER**

In the current study, 159 students responded to the open-ended questions about the advantages of the Chemistry OER. The answers were analyzed qualitatively. At first, each answer was recorded without any changes, and similar answers were grouped under topic headings. Similar topics were integrated, and four themes were determined: preparing for laboratory experiments, facilitating learning, shortening lab duration, and improving grades.

According to 71 students, the biggest advantage of the system was as a source of lab preparation. The other 55 reported that it facilitated and increased their level of learning during experiments, while 22 students mentioned that the Chemistry OER reduced the time required to conduct experiments. Lastly, 11 students revealed that the OER helped them prepare for quizzes, write reports, and improve their grades. Some examples of students' answers are listed below:

- Identifying the materials and knowing the procedure helped me to finish experiments faster and without errors.
- It is better to see the steps of experiments than reading them.
- OER helped me to understand experiments in advance, so I did not have difficulties conducting them.
- I had moderate knowledge in advance about what the lab assistant mentioned, so I was motivated to conduct experiments.
- It helped me to have advantage for lab quizzes. Just reading the steps of experiment was not adequate.
- Watching the ways experiments are conducted before the lab session helps us to reduce errors that may have happened during the experiment.
- It helped me to finish experiments faster and more efficiently.
- It was more joyful than studying on a book. Furthermore, it was so explanatory.

## DISCUSSION AND CONCLUSION

OER have several potential and known benefits for governments, institutions, educators, students, and life-long learners (Hodgkinson-Williams, 2010). In particular, instructors can share their knowledge with colleagues and students through OER without cost, anytime, and anywhere. Moreover, OER provide resources to other educational institutions and the greater academic community. The METU OCW portal is a prime example of a program that fulfills these tasks while serving many national and international visitors. The present study was conducted to shed light on this issue, since it is not yet known how these resources are utilized by or benefit learners.

Although the Chemistry Lab OER presents opportunities for all students, only a limited number of them actively used the system. This finding coalesces with the results of Oxford University's OER study, where students showed little to no awareness about the OER system (Masterman & Wild, 2011). Even though brochures and emails were sent to students during the present study, many claimed that they were not informed. Clearly, students ignore certain informative messages, and the OER should be advertised continuously through different channels with the help of instructors and teaching assistants. Students should also be informed via regular postings to social media.

Nearly half of the informed students did not use the system, much like in a study by Okonkwo (2012). In the present study, the most common reasons given by students for not using the system were relevant to having adequate information on lab flyers, not needing it, and not having enough time. Even though students were informed about the system, they underestimated the additional potential benefits towards their success. Thus, it appears that students should be more informed about the system, which would ultimately pave the way for increased usage.

According to the results, students mostly used the Chemistry Lab OER before lab sessions, akin to the flipped classroom method (Bishop & Verleger, 2013). In this method, students watch short videos prepared by their teachers to explain the key points of lectures prior to class. Such a method allows students to have more time to collaborate and interact during class periods. At METU, the case was a lab setting, so it might be considered a flipped lab application. Results revealed that the system helped slightly over half of the students gain a better understanding of activities and experiments. This finding overlaps with a recent study conducted by Dahlstrom, Walker, and Dziubans (2013), which showed that seven out of ten students preferred to use OERs over not to use it. In their study, one student used OER all the time, three used it occasionally, and the final three only experimented with it.

Students prefer to use OER only if they believe it will be beneficial to their success. Since students give significant credit to their peers' recommendations, channels for sharing their experiences with OER may encourage use. The qualitative analyses in this study showed that students see the METU Chemistry Lab OER as a valuable source of knowledge and a facilitator to learning. This result parallels the findings of Carson, Kanchanaraksa, Gooding, Mulder, and Schuwer (2012). In addition, findings indicated that the METU Chemistry Lab OER can shorten the duration of time that students spend conducting experiments.

Even though Carson et al. (2012), Lovett, Meyer and Thille (2008), Rhoads et al. (2013), and Okonkwo (2012) have indicated that the OpenCourseWare movement is a tremendous opportunity for both students and instructors, sufficient attention has not been paid to its instructional effectiveness. Most people are not aware of such systems or their benefits. OCW/OER systems should be improved and advertised more consistently for public use, both generally and specifically.

Overall, several findings were determined via this study:

- The motto, "If you build, they will come," is not valid for OER. Even free and valuable educational resources must be advertised to the target group.
- Although students had been informed of the OER via handouts and email, more than half of them were not aware of it. Building awareness is not a one-shot activity. Non-redundant communication strategies should be utilized, and all possible channels should be used regularly to promote the OER.
- Advertising should be done via social media networks used by students in addition to web postings, printed materials, and email.
- Professors should remind students of the OER frequently.
- Students should be encouraged to use the OER to prepare before class.
- Students prefer videos to interactive virtual experiments, so every OER should include video recordings.
- OER videos should have clear and detailed narration and subtitle options.
- Since effective use of OER may have positive effects on students' understanding and performance, they should be better informed about it.

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