EFFECT OF PROJECT BASED INSTRUCTION ON SCIENCE ACHIEVEMENT: AN EXPERIMENTAL STUDY WITH 7TH GRADE STUDENTS

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ABSTRACT

EFFECT OF PROJECT BASED INSTRUCTION ON SCIENCE ACHIEVEMENT: AN EXPERIMENTAL STUDY WITH 7TH GRADE STUDENTS

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The purpose of this study is to examine the effect of a project based learning (PBL) for 7th grade science unit titled "Cell and Divisions," in terms of academic achievement, compared to traditional science instruction. Four groups of students in two schools in Bodrum, Muğla participated in the study in the 2018-2019 Fall semester.

The intervention utilized pre and post-test control group quasi-experimental design with retention test where classes were randomly assigned to experimental (PBL) and control (traditional instruction) groups. "Cell and Divisions Achievement Test" was administered prior to, at the end of, and one month after the intervention.

The results were analyzed through t-test for independent groups. Post-tests yielded statistically significant difference between the groups in favor of the experimental

group in School B and of the control group in School A. In retention test, the experimental group in School B achieved significantly higher than the control group. Gain scores for both post-test and retention test were also analyzed showing that the experimental group in School B performed at a significantly higher level than the control group. Conclusions and implications were discussed in the last chapter.

Keywords: project based learning, science learning, academic achievement, experimental study.

ÖZ

PROJE TABANLI ÖĞRETİMİN FEN BİLGİSİ BAŞARISINA ETKİSİ: ORTAOKUL 7. SINIF ÖĞRENCİLERİ İLE DENEYSEL BİR ÇALIŞMA

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Bu çalışmanın amacı 7. sınıf Fen Bilimleri dersi "Hücre ve Bölünmeler" ünitesi için proje tabanlı öğrenme (PTÖ) yaklaşımına göre hazırlanmış programın akademik başarıya etkisini geleneksel eğitim yöntemiyle karşılaştırmalı olarak incelemektir. Araştırmaya 2018-2019 Güz döneminde Muğla'nın Bodrum ilçesindeki iki okuldaki dört sınıfta okuyan 121 öğrenci katılmıştır.

Araştırmada kontrol gruplu yarı deneysel ön-test son-test deseni kullanılmış ve ek olarak kalıcılık testi uygulanmıştır. Sınıflar PTÖ'nün uygulandığı deneysel ve geleneksel eğitimin uygulandığı kontrol grubuna seçkisiz atanmışlardır. "Hücre ve Bölünmeler Başarı Testi" gruplara eğitimin başında, sonunda ve eğitimden bir ay sonra uygulanmıştır.

Test sonuçları bağımsız gruplar için t-testi ile analiz edilmiştir. Akademik başarıya ait veriler ön testte deney ve kontrol grupları arasında anlamlı bir fark olduğunu

göstermektedir. Son test sonuçları Okul A'da kontrol grubu, Okul B'de ise deney grubu lehine anlamlı farklılık göstermektedir. Kalıcılık testinde ise Okul B'deki deney grubu kontrol grubundan anlamlı düzeyde daha yüksek puan almıştır. Ayrıca hem son test hem de kalıcılık testi için erişi puanları analiz edilmiş ve Okul B'deki deney grubunun kontrol grubundan anlamlı düzeyde daha yüksek puan aldığı görülmüştür. Sonuçlar ve öneriler son bölümde tartışılmıştır.

Anahtar kelimeler: proje tabanlı öğrenme, fen bilimleri, akademik başarı, deneysel çalışma.

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CHAPTER 1

INTRODUCTION

This chapter starts with a discussion of the educational background related to project based learning, followed by purpose of the study which includes research questions. Then significance of this study is discussed and finally, related terms are defined.

1.1. Background to the Study

In the ever advancing and highly competing world, education is one of the important means through which young people will be fostered to be able to meet the contemporary needs and demands. With the technologic development, globalization and changes in the labor market, economies all over the globe show the tendency of employing more people with higher education and secondary education and less people with primary education each year (International Labor Organization, 2017; Türkiye İstatistik Kurumu, 2017). Increasing demand for a specialized work force naturally changes the qualities individuals need to possess to be successful professionals.

Such professionalism calls for expertise in specialized fields and the way knowledge is utilized in a purposeful way. Expert knowledge is what individuals gain by their practice, training and experience for long periods of time (Booker & McNamara, 2004). Research done on experts shows that they draw on a vast body of extremely organized, previously learned, domain-specific knowledge (Bransford, Brown & Cocking, 2000). Extended knowledge and experience that were cumulated over time affects how they perceive systems and organize and interpret information which

allow experts to use their knowledge very effectively to solve authentic problems by efficiently recognizing a situation or problem and recall and apply the most effective solution to solve or fix them (Ericsson & Charness, 1994). Their reasoning typically is characterized as being automatic, abstract, intuitive, tacit, and reflexive. An expert on his/her domain can complete tasks while being unaware of what or how exactly he/she is doing it. (Kidd, 1987).

Developing such extensive and well-organized network of knowledge takes time and focus and requires opportunities for practice and feedback (Pellegrino & Hilton, 2012). Traditionally, it was thought that experts are trained properly and then gain knowledge over extended periods of time by practice (Chase & Simon, 1973; Richman, Staszewski & Simon, 1995). But, some scholars point out that the qualities of the environment in which experience is gained also affects expert knowledge (Camerer & Johnson 1997; Ericsson & Lehmann 1996; Shanteau, 1992). When feedback is often, fast and diagnostic and judgments are made in exacting environments expert knowledge tends to be more accurate. When feedback is low and delayed or wrong decisions are relatively not as punishing, experts are likely to struggle distinguishing the effect of their contribution from luck and tend to form superstitious beliefs (Kardes, 2006).

Such understanding on professional competencies involves deeper and meaningful learning, or transferable learning which is a combination of knowledge, skills and attitudes on a specific discipline that enables learners to retrieve and use what is known to address the novel tasks. This kind of definition of learning that promotes deep knowledge has seen support on the academic reports and influenced national educational policies in last decades. California Common Core State Standards (Bruton, Ong & Geeting, 2000) explains three guiding principles in mathematics instruction, fusing deep understanding of concepts and skills together: (1) focus, means that instruction should focus deeply on only those concepts that are emphasized in the standards so that students can gain strong foundational conceptual understanding, (2), coherence which arises from mathematical connections and (3) rigor requires that conceptual understanding, procedural skill and fluency, and

application be approached with equal intensity. On a report made by Hazelkorn (2015), European institutions recommend all citizens to have a better understanding of science and technology if they are to participate actively and responsibly in science-informed decision-making and knowledge-based innovation; and educational institutions, to boost understanding the importance of science education by learning about science through other disciplines and learning about other disciplines through science; strengthening connections and synergies between science, creativity, entrepreneurship and innovation. The commission also emphasizes on ensuring all citizens equipped with the skills and competences needed in the digitalized world starting with preschool. Ministry of National Education (Turkey), hereafter MoNE, stresses 'inspiring' students to show behaviors and attitudes that are not precisely taught, such as using information actively, or being responsible (MoNE, 2018). MoNE also points out that global tendencies sway governments to develop educational models which foster individuals who are responsible and able to solve problems, make decisions and think critically and innovatively.

It should also be noted that economies, especially industrialized ones, require specialized expert human resources with deep knowledge on their disciplines particularly on science related areas to keep their competitiveness (Capraro, Capraro & Çorlu 2014; Capraro et al., 2016; Committee on Prospering in the Global Economy of the 21st Century, 2007; Education, Audiovisual and Culture Executive Agency, 2012). In USA, this need led to the emergence of STEM (Science, Technology, Engineering, Mathematics), and in Europe MINT (Mathematics, Information Technology, Natural Sciences, Technology) which aim to amalgamate their related disciplines for more integrated and deeper understanding. Maker movement, another recent popular movement in USA, encourages people of all ages to make and tinker items in their everyday lives instead of being consumers, provide them with appropriate spaces to create and share their work (Dougherty, 2012; Halverson & Sheridan, 2014). It may be argued that other nations across the globe would also require same qualified human resource -not just in science related areas-

to foster economic growth and increased well-being for the people. It, naturally, fell to public education systems to provide individuals with wanted competencies.

But then, how to assess education systems in relation to whether they provide their students -prospective citizens and professionals- with required knowledge, skills and attitude to become such qualified individuals? International tests hope to achieve such purpose, yet caused quite controversy among educators in terms of validity. Still, they provide significant data in terms of educational policy and practice, hence they are examined here. One of such tests is OECD's Program for International Student Assessment (PISA). OECD (2016) aims to answer the question of "What is important for citizens to know and be able to do?" and conveys achievement tests for mathematics, science and literacy disciplines to 15-year-olds which aims to assess not only whether students can reproduce knowledge but also how well students can extrapolate from what they have learned and whether they can apply that knowledge in unfamiliar settings, both in and outside of the schools. Trends in International Mathematics and Science Study (TIMSS) is another international test, held on 4th and 8th grade students, spearheaded by International Association for the Evaluation of Educational Achievement (IEA). PISA pursues to assess to what extend students can use, interpret and communicate knowledge, in a way which does not rely solely on subject-matter knowledge, while TIMSS is focused mainly on specific curricular knowledge.

Countries around the world is striving to go beyond themselves and other countries in these examinations, as a token of accessibility and quality of public education. Turkey's achievement in these examinations has been limited so far. In PISA there is an increase on the average science scores except in 2015, but ranking is constantly dropping since 2009 and Turkey has never been above global average (Eğitimi Araştırma ve Geliştirme Dairesi Başkanlığı (EARGED), 2009; EARGED, 2010; Özgürlük, Ozarkan, Arıcı, & Taş, 2016; Yıldırım, Yıldırım, Yetişir, & Ceylan, 2013). On TIMSS average scores and rankings of Turkey are increasing steadily however scores are still below the world average. (Büyüköztürk, Çakan, Tan & Atar,

2014; EARGED, 2003; Şişman, Acat, Aypay & Karadağ, 2011; Yıldırım, Özgürlük, Parlak, Gönen & Polat, 2016).

Furthermore, national central examinations may be interpreted as a shortcoming in public education. MoNE (2017) in the 2016-2017 TEOG exam results reported that 8% of the students could not answer quarter of the science items, and 34% of the students could not answer half of the science items correctly. For mathematics, same thresholds could not be surpassed by 12% and 54% of the students respectively. Plus, data indicate the examination was easy due to negatively skewed distribution for all sub-tests.

To address these issues and reform the Turkish education system, MoNE introduced new policies such as participating PISA tests, extending years of compulsory education, increasing schooling rates especially for girls, increased funding, improving teacher education, generalizing information technologies in education since early 2000s (Çelen, Çelik & Seferoğlu, 2011; Sağlam, Özüdoğru & Çıray, 2011). From curriculum perspective the most important development was seen in 2004 when the new national curriculum program which promotes progressive approaches, methods and techniques over behavioristic ones issued for Turkish schools. MoNE advocated that the new program was progressive, spiral, based on school-parent cooperation, and utilized alternative methods and techniques to obtain knowledge, encouraged student inquiry, employed multiple measurement, used life as resource and adopted a managerial approach that centers students (Gelen & Beyazıt, 2007). Since 2004 several new curricula were issued for science education and in 2018 the most recent curriculum was implemented by MoNE, which can be considered as a continuation of the Ministry's constructivist education policy effort. Among its special purposes, MoNE states the curriculum aims to "adopt scientific inquiry approach to produce solutions in scientific problems, take responsibility on daily issues and using scientific and life skills to solve them, help understanding how scientific knowledge is created by scientists, its processes and its utilization in research, develop scientific thinking habits and decision making skills by using socio-scientific issues". Curriculum also indicates that it aims to nurture analytical

and creative thinking, entrepreneurship, communication, teamwork, innovative thinking skills along with observing, hypothesis making, modelling, manipulating, experimenting (MoNE, 2018).

However, despite reforms, Turkey's standings in national and international examinations have not improved drastically as stated earlier. Though this is likely to be caused by a complex set of reasons one of them may be the practices of the curriculum. Most studies in Turkey find that pre-service teachers see themselves as constructivists, however there is a discrepancy between their thoughts and classroom practices, as practice is more inclined towards traditional, behavioristic instruction (Çiftçi, Sünbül & Köksal, 2013; Doruk, 2014; Ogan-Bekiroğlu & Akkoç, 2009; Özdemir & Kıroğlu, 2011; Yılmaz, Türkmen, Pedersen & Huyugüzel-Çavaş, 2007). To nurture deep expert knowledge and to improve on the national curriculum, research on the new instruction methods might be fruitful. There is some research suggesting that traditional curriculum practices might not be the most suitable method for deeper knowledge (Gültekin, 2005; Venville, Wallace, Rennie & Malone, 2000) and may be one of the explanations for low student achievement. Instructional methods which allow higher levels of transfer may increase student learning. In this context, project-based learning is briefly introduced in the following paragraphs as a way to achieve this task.

There are many new approaches to teaching and learning that promise more meaningful and deep learning. As one of these approaches, project-based learning (PBL) is a form of instruction method based on principles of constructivism. Main assumption in PBL is that students gain a deeper understanding of material when they actively construct their knowledge by working with and using ideas (Krajcik & Blumenfeld, 2005). In PBL, students are asked to create an artefact with predetermined features as an end product of their learning experiences. Moursund (2003) defines PBL as a learning approach based on the principle that students work on real life issues/problems individually or in small groups to produce concrete outcomes. Krajcik and Blumenfeld (2005) highlight five key features of the PBL: a driving question to be solved, inquiry of the question by the students, collaboration

with community members to answer the question, utilization of technology to scaffold the students, and creation of tangible products that reflects the learning of the students.

Problems or driving questions in PBL are meaningful, challenging real world related situations or goals which serve to organize and drive activities students are going to engage. Problems may be selected by either designer of the program or students themselves. In any case, it is expected that while trying to solve these problems, students will acquire understanding and improve skills in subject area as well as non-subject related capabilities and at the end they will create an artefact as a representation of their learning. Teachers are more likely to be facilitators and coaches who provide expert guidance, feedback and suggestions for "better" ways to achieve the final product. The teaching (modeling, scaffolding, questioning, etc.) is provided according to learner need and within the context of the project (Savery, 2006).

Regarding to constructivist approaches, which PBL also fall under, Gardner (1991) states that the knowledge gained through active learning is constructive knowledge from active thinking and problem solving, and is not knowledge of memorizing and doing exercises for the teachers or doing homework from books. Bell (2010) more directly points out that the outcome of PBL is greater understanding of a topic, deeper learning, higher-level reading, and increased motivation to learn. Hence, it is supposed that utilizing PBL is a good choice in order to foster expertise in science domain since PBL either engages students with the similar activities that of experts in respective domains engage or scaffolds and strengthens them to be able to engage such activities.

PBL has been tried under different grade levels and various subjects, with promising results which are further discussed in empirical evidence section. However, implementation of the new science curriculum in middle schools, calls for more studies about the suitability of PBL in these new settings. In the old curriculum, two units that had been taught in different grades, are now merged, allowing students to have a more holistic understanding on the cellular biology. Inquisitive nature of PBL

may use this opportunity. Moreover, most experimental research conducted on PBL in Turkey, had no more than two classrooms. Relatively larger sample this study draws upon may lead into deeper insights on PBL. Therefore, there is a need to conduct a controlled experimental study with larger samples in middle school setting to investigate the effectiveness of PBL in terms of academic achievement under new science curriculum.

1.2. Purpose of the Study

This purpose of this study is to investigate the effect of project based teaching and learning on students´ achievement in a unit of 7th grade science course through a control group quasi experimental study. The specific research questions are the following:

1. Is there a significant difference between experimental (PBL) and control groups' science achievement measured by Cell and Divisions Post Test?

2. Is there a significant difference between experimental (PBL) and control groups' retention of science learning measured by Cell and Divisions Retention Test?

1.3. Significance of the Study

Science is a crucial subject for schools to teach. It is also a subject which students find hard to learn (Çimer, 2012; Jennison & Reiss, 1991; Tekkaya, Özkan & Sugur, 2001) so science education is an important topic for scholars and policy makers alike. Curricular efforts on science education has largely been influenced by constructivist ideas (Cobb, 1994; Dennick, 2016; Duit, 2016; Jenkins, 2000) that favor observation, experimentation, drawing conclusions and discussion of results and feedback, since these are parts of the process of scientific knowledge production. Turkey too decided to favor constructivist education approach since the paradigm shift in 2004. Constructivist approaches such as PBL may indeed prove helpful to students because

of their student-centered inquiry focus and close connection with real life. However, discrepancies were observed between reality and curricula in terms of teacher education, school facilities, management, curriculum and instruction even in recent studies (Çiftçi, Sünbül & Köksal, 2013; Ünder, 2010; Balbağ et al., 2016). International examinations such as TIMSS, PIRLS or PISA can be seen among the parameters that show the current situation of our schools, which aim to assess students' learning of curricular objectives and other capabilities that are not taught directly, yet extremely critical in the modern world such as scientific thinking or extrapolation. Turkey's standings in these tests are not satisfactory. To truly reform our educational system, learn how to create effective constructivist classrooms and help students in a way that meets today's demands and prosper as a nation, more research is needed on building effective classrooms, no matter they are constructivist or not. This study aims to contribute on building constructivist science classrooms.

Although constructivist methods are centered on students, teachers are still the most important people in the classroom in terms of facilitating the learning and guiding the students so that students' learning is focused and meaningful instead of disconnected pieces of surface information. Teachers should know about students' needs and how to scaffold them on the activities they are not able to perform on their own so that students can take the most out of the learning. However, this kind of competence requires mastery over theoretical and practical issues of the education. Teachers in Turkey when asked about their beliefs and thoughts about constructivist approach report high interest and attitude towards it, yet classroom observations show that they utilize predominantly behavioristic and teacher-centered methods (Fidan & Duman, 2014; Yıldırım, 2011). Although mixing methods to their strengths in relation with the subject, aims, student's age, previous learning, lesson hours etc. is required and suggested (Kirschner, Sweller, & Clark, 2006; Phillips, 1995), it should not be out of lack of required teaching skills. This study aims to test a model that is purely constructivist -while not advocating to utilize only one approach- and provides a testing ground for PBL and overall constructivist methods so that required teacher skills and qualities can be better understood to implement constructivist practice effectively. Findings of this study may inform the practices of faculties of

education for pre-service teachers. Also for teachers, since project work is required in the national curriculum, this study may help them to implement PBL programs or lessons in terms of goals, content, teaching-learning processes and evaluation in their classrooms. From schools and managerial perspective, it is important to understand what kind of facilities and materials schools need to have to implement constructivist programs effectively. Education superintendents and managers can draw from these results.

PBL is one of the most applicable methods that allow students to take responsibility of their learning (Bell, 2010). Project making can be utilized as a supportive or main learning activity to learn in schools however in either case aims, process and implementation require careful planning or curricula to be effective. Policy makers require studies such as this one to help them make informed decisions since this study suggests a science program for a new unit, with a plausible PBL method. Its results can be used in new or reviewed programs in terms of content, teaching-learning processes, or evaluation. In fact, this study is especially timely since the new program requires project work in science education. So that insights can be drawn about strengths and weaknesses of utilizing projects in education.

PBL is also beneficial to students according to the studies. The term 21st century skills has become ubiquitous in job market as much as in education (Mills & Treagust, 2003). Although there are many taxonomies for these skills, according to National Education Council (2012) term involves cognitive competencies (critical thinking, innovation, active listening etc.) intra-personal competencies (adaptability, self-monitoring, initiative etc.) and interpersonal competencies (leadership, communication, negotiation etc.). Dede (2010) adds technological literacy and competence over information technology. PBL creates a natural environment where students can freely create hypotheses, observe, experiment, manipulate, analyze, draw conclusions, reflect, build, design and criticize etc. which may be helpful to increase cognitive competencies. During projects they also take responsibility, persevere, schedule, refit, restart and use metacognition etc. to gain intra-personal skills. Lastly, since they are mostly going to work with small groups they need to

discuss, communicate their thoughts, mediate, compromise, organize people, lead and cooperate which can be useful for inter-personal skills.

PBL and results of this study may be important for a special group of students who are low achievers. According to some studies low achieving and disadvantaged students benefit more from PBL (Han, Capraro & Capraro, 2015; Mehalik, Doppelt & Schunn, 2008). PBL can be a means or a source to draw from, to lower the achievement gap between groups of population.

Another significance of the study is using experimental design with a relatively larger sample size. There are plethora of experimental PBL studies in Turkey and the world, however, especially in Turkey sample sizes are limited with two classrooms from one schools. These studies all suggest repetition with larger sample sizes. Two different schools with four classrooms may offer more diverse and richer data. Also most reviewed research were limited with post-test and did not include retention tests. The studies with retention tests may offer more understanding on the effect of PBL.

1.4. Definition of Terms

This key terms in this study were used in line with the specific definitions provided below:

Project based learning: A constructivist instruction approach with two main components: a question or problem that serves to organize and drive activities and creation of artifacts that culminate a final product to address the question (Blumenfeld et al., 1991).

Achievement: Student cognitive performance on Cell and Divisions unit, assessed by Cell and Divisions Achievement Test developed by researcher.

Intervention: 7-week project based learning oriented program for 7th grade science unit “Cell and Divisions” that experimental group was instructed with. Students formed groups of 4 to 6, to explore three driving questions regarding cell structure,

mitosis and meiosis, explored and constructed their knowledge by their own efforts such as research or experimentation and finally produced three projects for each driving question which satisfied the predetermined project conditions while teacher assisted them to gain accurate and deeper understanding.

Traditional instruction: Behavioristic and teacher-centered instruction in which classroom was mostly dominated by teachers' actions in a strictly structured environment. Teachers employed mainly lectures, whiteboard demonstrations, question-and-answer, and drills. Students listened, read, wrote, answered questions asked by teacher or followed the instructions of their textbooks, and thus adopted relatively more passive roles in the classroom.

Retention: Student success in Cell and Divisions unit one month after the end of instruction, assessed by Cell and Divisions Achievement Test.

Post-test gain score: Score derived by abstracting pre-test scores from post-test scores of the participants.

Retention gain score: Score derived by abstracting post-test scores from retention scores of the participants.

CHAPTER 2

REVIEW OF THE LITERATURE

This chapter has three sub-sections that review PBL literature. First constructivism is discussed as an overall framework for project based learning and constructivism in Turkey is overviewed, then PBL learning is introduced as a method inspired by constructivism along with other similar methods which were also inspired by constructivism. PBL is then discussed in terms of historical context, basic features and conceptual context. Third, previous research from international and national contexts on the impact of the PBL on student learning. Finally a summary is offered in relation to conceptual and research literature in relation to how it informs the current study.

2.1. Constructivism

Behaviorism and maturationism which were the predecessors to the constructivism conceptualized learning as mechanical, linear and independent of learner's control (Fosnot & Perry, 1996). These early approaches were criticized by some scholars for their mechanical and passive conceptualization of acquisition of knowledge. Jean Piaget, a prominent constructivist, claimed learning required active, deliberate mental effort on learner's part to create meaning and ultimately knowledge out of something. Main idea of the constructivism is that humans construct their knowledge, as they experience new stimuli. (Hoover, 1996). In other words, by investigating, talking or engaging various activities, an individual leans by building new knowledge on his/her existing knowledge (Grant, 2002). The learner cannot

passively accept information by mimicking the wording or conclusions of others. Rather, learner must engage himself or herself in internalizing and reshaping or transforming information via active consideration. Source of understanding is not external but human mind itself which constructs it through actively interpreting things (Ornstein & Hunkins, 2004). Another tenet of the constructivism is that previous learnings affect new learnings. There is no *tabula rasa* on which new knowledge is etched. Rather, learners come to learning situations with knowledge gained from previous experience, and that prior knowledge influences what new or modified knowledge they will construct from new learning experiences (Hoover, 1996). The literature on constructivism is extensive offering a great many names and perspectives. Among them, John Dewey, Jean Piaget and Lev Vygotsky are probably the most prominent figures in contributing to constructivism with their ideas and research.

Few researchers are as influential as John Dewey in education. He was one of the main proponents of the progressive education. With a belief that learning is lifelong, Dewey (1902) focused more on the child or the learner rather than on the subject matter:

> The child is the starting point, the center, and the end. His development, his growth is the ideal. It alone furnishes the standard. To the growth of the child all studies are subservient; they are instruments valued as they serve the needs of growth. Personality, character, is more than subject matter. Not knowledge or information but self-realization is the goal. Learning is active. It involves reaching out of the mind. It involves organic assimilation starting from within. It is he and not the subject matter which determines both quality and quantity of learning (p. 9).

Believing children live in the present, rather than preparing them for their future, Dewey pointed out that they should be educated ‘here and now’ perpetually, hence led to the famous motto of the progressive education: “education is life” (Oliva, 2009). Criticizing subordination of child to the curriculum, he urged educators to take children’s physical, emotional, mental, social, cultural and spiritual beings and differences into account in both envisioning and executing the education process. Teachers in this sense, instead of being a sources of information that matures the

students in a predesignated manner, conceptualized as facilitators of the learning to offer opportunities to every individual to employ his own powers in activities that have meaning (Dewey, 1916 as cited in Dodd-Nufrio, 2011), with a warning that they should not have the *laissez faire* approach, as stated before. Dewey explained the teacher role in their classrooms:

> Teachers are the agents through which knowledge and skills are communicated and rules of conduct enforced… (they) must have that sympathetic understanding of what is actually going on in the minds of those who are learning…any experience… that has the effect of arresting or distorting the growth of further experience (is miseducative)…every experience enacted and undergone modifies whether we see it or not, the quality of subsequent experiences… The most important attitude that can be formed is that of desire to go on learning (as quoted in Cömert, 2014, p. 10).

As Dewey contributed to the constructivism from an instruction approach, there were other scholars who focused on the human learning itself. One of such scholars, Piaget, suggested a developmental theory of human cognitive development which influenced constructivist approach. He proposed mental structures which were created by humans according to their experiences, are used to guide human understanding of the world. Piaget stressed that children actively construct their own cognitive worlds; information is not just poured into their minds from the environment. Piaget developed several important concepts in his theory: schemes, assimilation, accommodation, organization, equilibrium, and equilibration (Santrock, 2010).

According to Piaget, human minds create a mental representation of the knowledge and called these representations schemes. He suggests two types of schemes: behavioral (physical activities) and mental (cognitive activities). These schemes might represent objects (a baby's representation her pacifier or a dog), actions (an adult's representation of driving), strategies or plans (a child's representation of reaching to the cookie jar), or ideas (a teenager's representation of justice or evil). To explain how children create, use and adapt their schemes, Piaget offered two concepts: assimilation and accommodation. Assimilation occurs when children use their existing schemes to deal with new information or experiences. A child may

think all four legged creatures are dogs and add cows to the dog scheme. Accommodation occurs when the child adjust her schemes to take new information and experiences into account. When the child made the distinction between dogs and cows by their size difference and horns and created the new cow scheme, accomodation takes place and more complex and numerous schemes get created (Cohen, Kim, 1999).

To make sense out of their world, said Piaget, humans cognitively organize their experiences. Organization in Piaget's theory is the grouping of isolated behaviors and thoughts into a higher-order system. Continual refinement of this organization is an inherent part of development (Santrock, 2010).

As assimilation and accomodation are used to create more complex, higher order schemes, process creates a cognitive conflict, a state of disequilibrium in the mind. This occurs when human experiences significant amounts of experiences that are inconsistent with existing schemes or counterexamples. Piaget (1964) suggests that the urge to find equilibrium is inherent, so humans create new schemes, change the previous ones or make new connections between schemes to find equilibrium again. Eventually the organization fundamentally differs from the old organization, creating a harmony between schemes and environment. It is a new way of thinking.

Another scholar who contributed to the constructivism approach, Lev Vygotsky thought, just like Piaget, that learning required active mental participation on the part of the children. What makes Vygotsky unique is his focus on the social and cultural aspect of learning while Piaget focused mainly on individual cognitive abilities.

Vygotsky believes a child come to this world capable of learning. He does not focus on the developmental stages of the child though, rather the learning process that happens at two levels. First it happens between people, such as talking with mother or having an experience with another friend. Second, it happens within. Child learns as new concepts are introduced and more meaning is attributed to the object (Clark, 2001, as cited in Çiftçi, 2006). Conceptualizing social interaction as a prerequisition of learning, Vygotsky stresses the importance of more capable people and suggests

that child mentally develops when he is coordinating with said people. Cognitive development progresses from behaviours that are organized by others to behaviours that are organized by self (Senemoğlu, 1997).

In his works, mentioned principle is conceptualized as Zone of Proximal Development (ZPD). As defined by himself, ZPD is "the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1980). In ZPD framework, there are four stages while children and more capable people are cooperating: (1) Work must be scaffolded by the capable person, (2) Work must be supported by the child who is utilizing egocentric speech to guide himself, (3) Work must be improved and automated, (4) Work becomes automated and can be improved into a more complex task with ZPD (Bodrova & Leong, 1996, as cited in Çiftçi, 2006).

Finally, there are several main tenets of constructivism that influenced PBL. One and foremost is the Piaget's idea of active acquisition of knowledge which urged educationalists to create curriculums and models that allow students to seek, analyze and evaluate and transform knowledge actively rather than just exposing students to knowledge. A point is humans learn and make meaning through previous learning. Since people have different backgrounds, so are their knowledge about a subject. This also means that to be able to share similar or coherent knowledge, people must seek it together. Importance of cooperation and social and cultural aspect of the knowledge is further investigated by Vygotsky. Beyond just stating the importance of cooperation, he also propounded cooperating with more capable people allow novices to learn more than they can learn by themselves. Dewey, sharing similar thoughts with Piaget and Vygotski, contributed constructivism by conceptualising it in education setting. Comparably, he emphasized experiences of the children and importance of participation, thus, suggested child centered classroom and provided teachers and other educationalists to how to design progressive classrooms. Project based learning, which is further discussed on the next section, features all mentioned characteristics.

Constructivism became the main theory of education that influenced curriculum efforts in Turkey since 2004. As stated earlier, in part of the modernization movement, MoNE changed its curricular policies from linear, behavioristic curricula to constructivist and wholistic ones. The change naturally brought contraversy among scholars, and although the change was recieved as a step in the right direction, there is a large group of scholars who pointed out that it was too sudden and large to adjust quickly and well enough in terms of teacher education (Aydın & Çakıroğlu, 2010; Aydın & Boz, 2012; Duru & Korkmaz, 2010; Karacaoğlu & Acar, 2010), required tools and materials supply (Çiftçi, Sünbül & Köksal, 2013), school facilities and class size (Yelken, Üredi, Tanrısever & Kılıç, 2010) or clear and precise definitions and vision on curricular documents (Ünder, 2010). In their study, Balbağ et al. (2016) grouped problems of current science education into four categories: teacher based, phsyical and environmental based, student based and curriculum based ones. Yıldırım (2011) found that teachers promote passive students behaviors more often than active ones. Thus, it can be said for the last 15 years has been a phrase of designating and solving the problems of the transition and there is still a significant discrepancy between what is written and what is actually being done. Although public documents envision constructivist, student-centered, progressive curriculum and overall education, in reality schools, especially teachers, are struggling to embrace the new vision out of both intrinsic and extraneous reasons.

Yet, this phase of experience has bright sides as well. Çelen, Çelik and Seferoğlu (2011) point out increased schooling rate among girls, increased the lenght of compulsory education, free textbooks, increased scholarship opportunities and especially more widespread utilization of information technologies to support constructivist learning as beneficial developments. Çiftçi, Sünbül and Köksal (2013) report younger teachers who were educated with new approaches are more willing to use them than their more senior collegues. Additionally, less orthadox private schools such as Başka Bir Okul Mümkün provide alternative education options that revolve around student-centered teaching, democratic management, ecologic stance and unique funding.

It can be said that MoNE is persistent to modernize the education however, process has limited success so far. Although some good happens, reports of the scholars point out very significant drawbacks realizing what is written in Turkey's formal curricular documents. Next, project based learning is discussed.

2.2. Project Based Learning

Constructivism has inspired several teaching methods such as problem based learning, inquiry based learning, discovery based learning and project based learning. All these methods allow students to discover, build and share their knowledge as they observe, hypothesize, experiment, analyze, draw conclusions, discuss the world around them. Problem based learning, according to Hmelo-Silver (2004), learning revolves around complex problem that does not have only one correct answer. Students engage self-directed learning and use their understandings to solve the problem, reflect on their learning and effectiveness of their strategies. Inquiry based learning, according to Pedaste et al. (2015) is an educational strategy which enable students to discover contributing relations, form hypotheses, and testing them via experimenting or observations. They also suggested that inquiry based learning has five phases: orientation, in which introduces the topic of inquiry; conceptualization, in which students question and generate hypotheses for their inquiry; investigation, in which hypotheses are tested through collected data collected by experimenting or observations; conclusion, in which findings are refined into inferences, explanations, models or solutions in relation with the topic, and finally discussion, in which findings are communicated with the learning community and fine tune and reflect on the findings according to the feedback.

Discovery based learning as summarized by Alfieri, Brooks, Aldrich and Tenenbaum (2011) takes place whenever students are not given direct understanding of the subject and have to find those themselves. Sources and guidance may or may not be provided by the educators. It should be noted that these definitions and explanations are not universally agreed upon, yet mostly describe their framework. As it is

explained in the following paragraphs, project based learning has a lot of commonpoints with aforementioned methods. Curriculum objectives and lesson plans are less structured than behavioristic approaches and allow students freedom. They are active learners where they themselves -often in small groups- question, hypothesize, experiment and draw conclusions about the topic and build their own understandings. Correspondingly, teachers serve as helpers, facilitators and guides to the students instead of sole sources of knowledge (Hyslop-Margison & Strobel, 2007; Jones & Brader-Araje, 2002; Scheer, Noweski & Meinel, 2012).

Thus, it is easy to see the philosophical similarities, yet there are some differences in the practice which makes them stand out under different settings. Although project based learning can be classified as discovery based or inquiry based learning, since inquiry and discovery happens in project making process, it has specific distinctions especially when compared to problem based learning. In problem based learning students often try to identify, understand and fix a hypothetical or real world problem through hypothesis making, gathering data, analysis, drawing conclusions. An example can be given for problem based learning in form of a patient case where they try to identify causes, make diagnosis, and offer treatment for. Process usually ends with a report. In project based learning, too, there are problems or driving questions which students try to solve or fix, furthermore students do actively search for knowledge and use similar scientific method.

Perrenet, Bouhuijs and Smits (2000) claim that projects are more authentic to the professional reality, they are more directed to the application of knowledge, management of time and resources is as important as the task itself, and it allows for more freedom when compared to problem based learning. Kokotsaki, Menzies and Wiggins (2016) also propound that project based learning gives higher autonomy to the student in terms of how the driving question can be approached. A project can be a poster, song, game, experiment, model, video etc. Thus, projects allow teaching and exploration of various subjects to a greater range of students. Also, projects are concrete learning objects which allow students to materialize their understandings, they can be easily shared for feedback and due to this, enable further improvement

to gain further knowledge on the subject as the learning process takes place (Helle, Tynjälä & Olkinuora, 2006). Finally, projects are a good choice for a classroom that is used to be instructed by mainly teacher-centered and behavioristic approaches since project work is utilized under those settings and both students and teachers are not completely inexperienced at making projects.

Indeed, using projects in education is not new, educators utilized projects to approach subjects in an open ended way and foster student autonomy. One of the earliest use of projects in education was reported by Knoll (1997) for architectural education in 16th century Italy. Knoll, then, divides the history of project method into five phases:

> 1590-1765: The beginnings of project work at architectural schools in Europe.
> 1765-1880: The project as a regular teaching method and its transplantation to America.
> 1880-1915: Work on projects in manual training and in general public schools.
> 1915-1965: Redefinition of the project method and its transplantation from America back to Europe.
> 1965-today: Rediscovery of the project idea and the third wave of its international dissemination (p. 2).

Naturally, throughout the history concept of project and its utilization in education have evolved. Kilpatrick, one of the earlier proponents of project method, (as cited in Burlbaw, Ortwein & Williams, 2013) defined project as "a hearty purposeful act". Whatever the child undertook was considered a project as long as it was done purposefully. Contrary to modern scholars, his definition did not link the project to specific subjects or tangible artifacts. However this approach was criticized by Horn (1922) arguing value of the projects lied on its connection with life rather than pure student interest. Freeland (1922) emphasized essential feature of the project as provision of 'something' to organize, investigate or accomplish. In the following years project method become more structured by teachers and education planners, as Dewey (1934) reminded "It is the business of the educator to study the tendencies of the young so as to be more consciously aware than are the children themselves what the latter need and want." Also, Tanner and Tanner (1980) said:

> … experience had made it abundantly clear to many educational theorists that a curriculum based solely on the spontaneous interests of childhood was an impossibility. Such a program could have no sequence and no predetermined outcomes, not even predetermined psychological outcomes. Even a play school had to have objectives and a program that was planned to meet those objectives. Otherwise, the child might as well stay home (p. 296-297).

In 1960s projects were reintroduced in American schools. This time focus was on the discipline and the subject, and not heavily on the child as Kilpatrick argued. Educators argued the thrill of making a discovery independently in a subject would motivate students to discover more. Discovery teaching was a disciplinary effort to teach children to think like scientists instead of children (Tanner & Tanner, 1980).

Stemming from these ideas, PBL was one of the many instruction methods constructivist educators developed. PBL is an instructional method where students are asked to create 'artifacts' to solve or address a meaningful problem of the discipline. As they are exploring the problem, planning and managing their tasks, collecting and analyzing data, raising further questions, cooperating with other people and creating their artifacts rich, deep learning occurs. It is rather a social kind of exploration and learning process since they can construct and present knowledge or meaning without producing external products, the processes of construction are more evident when learners produce through social interaction with others and share representations of their understanding and thoughts (Orey, 2012), allowing experts to give further feedback and guidance, if needed. Another important element is that artifacts must be personally meaningful, where individuals are most likely to become engaged in learning. By finding a balance between the individual learner and learning objectives, project-based learning strives for "considerable individualization of curriculum, instruction and assessment" (Moursund, 2003).

Although there is no definition about PBL that is agreed by all the scholars in the field, there are some who suggested a number of principles to create a framework. Blumenfeld (1991) wrote:

> PBL is a comprehensive perspective focused on teaching by engaging students in investigation. Within this framework, students pursue solutions to nontrivial problems by asking and refining questions, debating ideas, making predictions,

> designing plans and/or experiments, collecting and analyzing data, drawing conclusions, communicating their ideas and finding to others, asking new questions and creating artifacts (p. 371).

Krajcik and Blumenfeld (2005) argue there are five key features of the PBL:

1. They start with a driving question, a problem to be solved.
2. Students explore the driving question by participating in authentic, situated inquiry – processes of problem solving that are central to expert performance in the discipline. As students explore the driving question, they learn and apply important ideas in the discipline.
3. Students, teachers, and community members engage in collaborative activities to find solutions to the driving question. This mirrors the complex social situation of expert problem solving.
4. While engaged in the inquiry process, students are scaffolded with learning technologies that help them participate in activities normally beyond their ability.
5. Students create a set of tangible products that address the driving question. These are shared artifacts, publicly accessible external representations of the class's learning (p. 318).

Similarly, Thomas (2000) wrote that there are five criteria for a project utilization in education to be considered PBL: centrality, driving question, constructive investigation, autonomy and realism.

"Centrality" means curriculum is formed by projects as a central teaching strategy. Subject concepts and information must be engaged, investigated and learned through projects. So, projects that reinforce the material that is taught by other instructional methods are not PBL, by this principle. Also, projects that engage students in concepts that are outside of curriculum objectives are not considered PBL either.

"Driving question" guides instruction and it is meaningful and important to the students in terms of real life resemblance. It urges students and arouse curiosity to explore the discipline and allows them to discover key concepts, principles and information as they try to answer the question. Good driving questions have several features. Driving questions should be (1) feasible in that students can design and perform investigations to answer the question; (2) worthwhile in that they contain rich science content that aligns with national or district standards and relates to what

scientists really do; (3) contextualized in that they are real world, nontrivial, and important; (4) meaningful in that they are interesting and exciting to learners; (5) ethical in that they do no harm to individuals, organisms or the environment (Schneider, Krajcik, Marx, & Soloway, 2002). Selection of the driving question can be made either by teacher or students.

In PBL students must purposefully investigate the driving question in a way which involves inquiry, knowledge building and resolution (Thomas, 2000). Students are expected to plan and manage their work, collect and analyze data, ask questions, come to conclusions, collaborate with others and create products/artifacts on their own to transform and construct their understanding during investigation phase. Although teacher guidance is vital to guide, focus and improve the student effort, "constructive investigation" principle necessitates active student participation since if the essential activities of the project pose zero to little challenge to student or can be carried out with already learned skills it is not PBL, but an exercise.

PBL activities are mostly driven by students instead of teachers. PBL projects incorporate a good deal more student autonomy, choice, unsupervised work time, and responsibility than traditional instruction and traditional projects (Thomas, 2000). Exercises or drills of teacher taught subjects with expected results are incompatible with the "autonomy" principle.

PBL activities resemble real life situations, instead of school-like experiences. Gordon (1998) defines three kinds of challenges: academic, scenario and real-life. Projects in PBL are included in the third kind of challenges. PBL activities aim to solve problems that are -in some extend- experienced in real life, to offer solutions that are potentially implementable or to emulate the way real experts of the discipline work. So, projects in PBL give a feeling of authenticity to the students in terms of topic, activities that are needed to be done, collaborators, end-product and audience of the project.

The most distinctive feature of the PBL is the artifacts which showcase inquiries and examinations of the students regarding the driving question. Students can develop

all sorts of projects ranging through songs, plays and drawings to posters, reports, videos and physical models; in fact advanced project works may include software, Web site or computer model creation. Effective projects address the driving question, display the learning of the students and further support them to understand the learning goals of the subject of the said project. (Krajcik & Blumenfeld, 2005). Projects allow students to review and manipulate ideas -similar to what real experts do to solve authentic problems in their professions-enabling them to transform their knowledge and use their understandings to create a tangible products. These products then can be shared with others in the discipline for further feedback and opportunities for more learning.

Finally, retention of knowledge and its relation with PBL were discussed in this section. Retention of knowledge or knowledge retention is defined as keeping learned knowledge correctly over long spans of time. According to Cognitive Load Theory (CLT), there are two main structures of the cognitive architecture: working memory and long-term memory. Former is extremely limited in its capacity to hold information, no more than 2 or 3, however is able to 'work' with or transform the information while latter is seemingly limitless but not capable of transformation of knowledge. Long term memory is capable of holding a great number of schemas, which are the incorporation of multiple elements of information into a single one, or in other words, compressed 'chunks' of knowledge. Compressing knowledge into schemas takes place on the working memory which is called automation and allows working memory to work with further efficiency, without overburdening its limited capacity. So, learning and retention of it, from the CLT point of view is a matter of creating or acquisition of schemas and organizing them into more compressed or automated 'chunks' on the long term memory. For learning to be happened, ideally, working memory is supposed to allocate as much as its limited process capacity for acquisition and automation, which is called germane load, however CLT defines other types of loads that draw from the working memory capacity, hindering acquisition and automation of the learning and ultimately lead to poor retention (Paas, Renkl & Sweller, 2003; Sweller, 1988).

Those loads are called intrinsic load and extraneous load. Intrinsic load is linked with element interactivity or simply, difficulty or complexity, of the learning subject. Intrinsic load cannot be reduced but only broken into smaller pieces. Extraneous load on the other hand is caused by ineffective presentation of information or instruction such as trying to understand an ill-written explanation (Chandler & Sweller, 1991). With suitable instruction extraneous load can be reduce to allow germane load more working memory processing resources, such as providing step-by-step explanations, logical progression of the concepts, structured lessons etc. So that, learning and knowledge retention are facilitated.

Neuroscience also has something to say about knowledge retention. Hippocampus, specialized brain area for memory is very close to a small area called amygdala, center for emotional arousal (Rogers, 2011). According to research activation of amygdala during learning process increases knowledge retention level which means emotional arousal, especially negative emotions such as fear, increases knowledge retention (Chittaro & Buttusi, 2015; LaBar & Cabeza, 2006; McIntyre, Hatfield & McGaugh, 2002; Nielson & Arentsen, 2012). This means lessons which are exciting, surprising, require caution and mindfulness in a potentially dangerous situation may be beneficial on knowledge retention.

PBL can enable such environment in science teaching via hands-on learning opportunities provided by lab work, experimenting, observation of organisms, building a variety of machines or items etc. On the next section, empirical evidence on PBL is reviewed.

2.3. Empirical Evidence

A large body of research both in the world and in Turkey have been carried out on PBL. Part of the studies evaluated the effectiveness of the PBL in terms of academic achievement scores, while others focused on student skills and characteristics. Some of the studies aimed to assess student attitude towards the topic. Researchers used various methods such as experimental designs, case studies, action research, and

meta-analyses. This part offers a selection of research on PBL from education literature, both from Turkey and around the globe. While focusing more on science education in middle school setting, different subjects in other settings were also given place to describe a broader view on PBL. It must also be stated that some of the mentioned research below cannot be classified as PBL, but project work, by the definitions and principles given above, however they are still included in this study due to their significance of showcasing the potential of PBL and non-agreement of PBL definitions by all scholars. Studies that are most relevant by subject, and grade level were presented first.

Korkmaz and Kaptan (2001) aimed to assess the effect of PBL on academic achievement, academic self-concept and study time under a 7th grade science class setting. They worked with one control group and one experimental group where the former was instructed by a rather traditional approach focusing on textbook and lecture, while the latter was instructed by PBL. Results for academic achievement, academic self-concept and study time all showed significant difference between groups in favor of experimental group.

Çiftçi (2006) carried a study with 41 middle school students for 14 weeks where he investigated PBL efficiency in terms of academic risk taking, problem solving ability and achievement in social studies subject. Traditional and PBL groups were compared with pre-test post-test quasi experimental design. He resulted that (1) there is no significant difference in academic risk taking level, (2) there is no significant difference in students' problem solving abilities, (3) there is a significant difference in students' achievement levels in post-test in favor of the experimental group, (4) there is a significant difference in the students' retention level in favor of the experimental group, (5) there is not a significant difference between students' attitudes to the social studies course.

Girgin (2009) aimed to examine the effects of project based learning on the achievement and the attitude of the 5th grade students in science subject. In her quasi-experimental study she compared traditional instruction with a PBL course that takes 9 weeks. She found significant difference in groups' post-test results in academic

achievement test, however no difference between the groups in terms of attitude was observed.

Çeliker and Balım (2012) used PBL in Science and Technology unit “Solar System and Beyond: Space Puzzle” and investigated its efficiency in increasing academic achievement. In their quasi-experimental pre-test, post-test setting 26 of the total 53 7th grade students were instructed by PBL instruction for four weeks, while 27 were instructed by regular Science and Technology curriculum. Results suggested that there was a significant difference in terms of academic achievement between experimental and control groups in favor of the former.

Schneider, Krajcik, Marx and Soloway (2002) enrolled 142 10th and 11th grade students in project based science program (PBS). These students then were assessed by a national central examination after they graduated from 12th grade. When compared to subgroups identified by the exam, it was seen that PBS students outscored the national sample on 44% of the test items.

Han, Capraro and Capraro (2015) examined the effectiveness of STEM/PBL activities on students with various performance levels and to what extent personal differences influenced their mathematic achievement through three years. 836 high school students from different socioeconomic backgrounds took achievement tests and researchers found out that students from different demographic backgrounds and performance levels were affected differently by the treatment. Surprisingly, low performing students showed significantly higher growth rates when compared to that of high and middle performing students’ over three years. Researchers concluded low performing students enjoyed higher benefits by STEM/PBL and it can be utilized to decrease the achievement gap.

Venville, Wallace, Rennie and Malone (2000) presented a case study of 9th grade students where they participated in a technology project which asked them to build a solar powered boat. Project involved both science and mathematics components on electric circuits, statistical analysis, critical pathways and reading sun charts. Three pairs of 9th grade students who were thought to be more articulate than their peers,

were purposively selected in Academic Talent Program. Research involved observations in classes, interviews with students and teachers and studying the portfolios made by students. Researchers concluded students displayed profound understanding of science, math and technology topics through production of a sun-powered boat. They actively used knowledge from all three areas and trial-and-error nature of developing a project facilitated deeper understanding in them.

Mehalik, Doppelt and Schunn (2008) compared effectiveness of design based systems approach with traditional scripted inquiry in middle school setting. Students' gender, ethnicity and socioeconomic status were also taken into consideration. Students were asked to produce an electrical alarm system in four weeks to learn concepts of electricity with the help of authentic engineering design methods. The contrast study took place in the eighth grade of an urban, public school district, with the systems approach implemented in 26 science classes (10 teachers and 587 students) and the scripted inquiry approach implemented in inquiry groups of 20 science classes (five teachers and 466 students). Data suggest that the design approach yielded significantly better results in terms of knowledge gain achievement on core concepts, engagement, and retention when compared to the inquiry approach. Similarly to the previous study, low achieving African American students benefitted more than other groups.

The studies reviewed this far were primarily focused on academic achievement by using pre-test post-test quasi experimental design from Turkey and the world. Although most of them took relatively short time like 4-5 weeks, some of the studies are quiet long paced, while the longest one being a 3 years of longitudinal study. All these studies indicate the strengths of PBL for increasing the academic achievement or general understanding about the subject under various settings. Two of these studies investigated PBL in terms of central national examinations, about which are commonly thought that traditional instructional methods are more successful to prepare with. Interestingly, their results show that students prepared with PBL are as successful as their traditionally prepared counterparts. Also, some of the studies

found that low-achieving students benefit more from PBL and argued it can be used to reduce the achievement gap between advantageous and disadvantageous groups.

Çıbık (2009) studied the effect of PBL approach in teaching physics unit "Simple Machines" in terms of developing attitude towards science education with 7th grade students. 44 students were participated to the quasi-experimental research. Students in the experimental group were asked to design and complete a project in six weeks. After the research, meaningful difference between groups was observed in terms of their attitudes towards the lesson, favoring experimental group students.

Kırkan (2018) investigated effects of a PBL robotics course with seven gifted middle school students. He concluded that the course improved their creative and reflective thinking and problem solving skills. On his follow-up he observed that they were still engaged with robotics after 8 month later and deduced their attitude towards the subject were increased.

Baş and Beyhan (2010) tested PBL under middle school English education setting where they implemented multiple intelligence supported project based learning unit to 50 5th grade students. They used quasi-experimental pre-test post-test design and concluded attitude of the students in the experimental group increased more than of control group students. They also observed significantly higher motivation and achievement scores in the experimental group.

Saracaloğlu and Çelik (2018) conducted a qualitative study where they held used semi-structured interviews with 24 11th grade students about their opinions on the Web Design and Programming lesson. Findings suggest PBL allows more effective learning, active participation; increases retention and motivation. On the other hand students also complaint about lack of theoretical knowledge, insufficient lesson time and inadequate materials and infrastructure.

As aforementioned studies indicate, from the attitude perspective, PBL is mostly successful. Students under various settings report higher attitude to the class when they were taught by PBL. On the other hand, there are studies which contradict with

this claim, such as Çiftçi's (2006) study which might be attributed to length of the instruction.

Aydın, Atalay and Göksu (2017) aimed to develop students in a more successful and enterprising way to enable them to do their own research and projects. They wanted to investigate this opportunity on their self-efficacy and academic motivation. Their single group pre-test post-test experimental study was participated by 42 students who carried out projects in the subjects of their choosing. According to the data, intrinsic motivation levels were increased significantly towards their respective subject after the treatment. Levels of external motivation, introjected motivation and amotivation however did not change.

Hung, Hwang and Huang (2011) carried out a quasi-experimental pre-test post-test study with a total of 117 5th grade students in Taiwan where experimental group used a special information searching system to answer teachers' driving questions and made short videos out of their findings. They also investigated motivation, problem solving competence, achievement tests. Results suggest experimental group outscored control group under every category.

Liu and Hsiao (2002) reported a PBL approach where students were asked to engage designing multimedia under middle school settings. One of the two research questions they were aimed to answer was whether the multimedia designing environment had any effect on their motivation towards learning; while the second one investigated whether the cognitive strategies employed by students during the study were affected by designing multimedia products. Research utilized both quantitative and qualitative data and results yielded that environments that enable students to design and create help students to better solve problems, be independent and make effective decisions. Their cognitive strategy use and motivation levels were also positively affected by the treatment.

Husamah (2015) used Blended Project Based Learning to investigate metacognitive awareness in undergraduate students. In his quasi-experimental research with nonequivalent control group design, he observed mean values in metacognitive

awareness (knowledge about cognition and regulation of cognitive) of the treatment group was significantly higher than of the control group's and resulted that Blended Project Based Learning can be used effectively to develop and stimulate metacognitive awareness of biology teacher candidates.

Grant and Branch (2005) investigated effects of PBL on a geography class. They purposefully selected only five participants out of 61 8th grade students to study the personal differences and especially abilities were utilized in the process of creation of computer-mediated projects. Mostly qualitative data were collected through observation, interview, artifact assessment but self-report inventories were also used as well. According to the results, artifacts students created reflected their personal differences through a blend of their abilities. However some abilities students reported they had could not be found. It was concluded that artifacts represented students' knowledge in three ways: system knowledge, domain knowledge, and metacognitive knowledge. Some blends of knowledge however could not be observed. Researchers also found out that flexibility in the learning environment helped students to be better decision makers and organizers in their projects.

These reports suggest PBL is beneficial for motivation, since it allows students to engage the topic with autonomy, and a group of skills such as problem solving or metacognitive awareness.

Kaşarcı (2013) in his meta-analysis reviewed 177 studies from Turkey which compare PBL and traditional instruction. 85 out of 177 were selected for the analysis. 53 studies focused on achievement and 32 focused on attitude. Results show that effect size for achievement is a large one, for attitude however it was medium. Analyses also show achievement is differentiating with regard to subject area, however not for attitude. Educational setting seems to not matter in terms of both achievement and attitude. Duration of the treatment also seems to differentiate the achievement levels while it does not differentiate attitude levels.

It should also be noted that there are some scholars who report constructivist methods such as PBL can be counterproductive especially when sessions are not structured

enough to guide students to their projects, in that case, too much autonomy can be detrimental to the effectiveness of the lessons. Harmer and Stokes (2016) interviewed freshmen undergraduate students and their tutors about their PBL geography, earth and environmental sciences workshop and analyzed staff-student discussions and found out that although some autonomy is welcomed, students preferred more structured instructions on what to do. Similarly, advocates of Cognitive Load Theory also suggest that due to finite capacity of the working memory, discovering new things without guidance lead to inefficient learning and misconceptions, and claim effective learning takes place under strict instructional guidance (Sweller, 1988).

The research review showed PBL was studied under various grade levels, subjects and research designs. In Turkey two major research interests regarding PBL were academic achievement and attitude towards the subject. According to all studies carried out in Turkey PBL had a positive effect on academic achievement compared to more traditional instruction. But most research used post-tests only with no retention tests. On the attitude, results are conflicted, likely due to relatively short duration of instruction to cause a change of attitude. Some studies investigated various concepts such as motivation, self-efficacy, problem solving, risk taking, academic self-concept. Although Çiftçi's (2006) study found no significant different between groups for risk taking and problem solving levels, other researchers resulted that students who instructed by PBL enjoyed higher motivation, self-efficacy and higher academic self-concept. Research done in Turkey shows PBL has been investigated under various settings and for different subjects, although most research is limited by instruction time, two classrooms and one post-test, and there are few studies which inquired the reason of difference between PBL and traditional groups.

In other countries, similar to Turkey, studies investigating the effect of PBL over academic achievement compared to traditional approaches and yielded similar results where PBL proved more effective than traditional instruction. Unlike Turkey though, there were some studies that tested PBL longitudinally and with higher numbers of participants by taking socioeconomic status and previous achievement

level into consideration. Surprisingly, they reported low achieving students and students from lower socioeconomic status enjoyed more growth by PBL compared to other achievement and socioeconomic groups. There were also some research investigating the cause of the difference between PBL and traditional groups. One study tested PBL in a national examination and included data about types of questions that PBL students were more successful than their traditional counterparts. Other research suggested PBL helped student by increasing metacognitive awareness, cognitive strategy use and motivation.

CHAPTER 4

METHOD

This section describes overall design of the study, research questions and hypotheses, population and sample, treatment, instruments, data collection, data analysis ethical issues, threats to internal validity, limitations and assumptions.

3.1. Overall Design

The purpose of this study is to investigate the effect of project based teaching and learning on students´ achievement in a unit of 7th grade science course through a control group quasi experimental study. Overall design of the study can be seen in Table 1.

In experimental studies, effect of at least one independent variable over one or more dependent variable is investigated. Randomization is one of the most important characteristics of the experimental studies and there are two kinds of it: Random selection and random assignment. Random selection means that every member of a population has an equal chance of being selected to be a member of the sample. Random assignment, on the other hand, means that every individual who is participating in an experiment has an equal chance of being assigned to any of the experimental or control conditions being compared. In quasi experimental designs random selection is neither possible nor feasible. To control internal threats that this design poses, matching can be used. In matching, individuals in experimental and control groups are matched in certain characteristics (Fraenkel, Wallen & Hyun, 2011).

In this study, assigning individuals into the experimental and control conditions was not possible, thus quasi-experimental design with intact groups was utilized. As quasi-experimental design suggests, intact groups were assigned randomly into experiment and control groups.

Table 1.

Overall Framework of the Study

Research Problem	Research Questions	Instruments	Analysis	Participants
Examining the effect of PBL on academic achievement in 7th grade sciences	1. Is there a significant difference between experimental and control groups' science achievement measured by Cell and Divisions Post Test?	"Cell and Divisions" achievement test (post)	t-test comparing control and experimental groups' post-test scores, t-test comparing gain scores of experimental and control groups	4 intact 7th grade classes from the two schools located in Bodrum, Muğla. Two experimental and two control groups
	2. Is there a significant difference between experimental (PBL) and control groups' retention of science learning measured by Cell and Divisions Retention Test?	"Cell and Divisions" achievement test (retention)	t-test comparing experiment and control group retention test scores, t-test comparing gain scores of experimental and control groups	

As pre-test, both groups took Cell and Divisions Achievement Test. On the intervention phase, experimental group was subjected to PBL oriented instruction while the control group went through traditional instruction for "Cell and Divisions" unit. Following the treatment, both groups took the Cell and Divisions Achievement Test again as post-test. Retention tests were also given to both groups one month after the treatment. The experimental design is illustrated in Table 2.

Table 2.

Quasi Experimental Design of the Study

Groups	Pre-test	Treatment	Post-test	Retention
Experimental Group	Cell and Divisions Achievement Test	PBL oriented teaching and learning sessions	Cell and Divisions Achievement Test	Cell and Divisions Achievement Test
Control Group	Cell and Divisions Achievement Test	Traditional program	Cell and Divisions Achievement Test	Cell and Divisions Achievement Test

3.2. Research Questions and Hypotheses

The purpose of this study is to investigate the impact of project based teaching and learning on students´ achievement in a unit of 7th grade science course through a control group experimental study. PBL unit constituted the intervention of this study. The main research problem the study engages is to examine the outcomes of PBL in 7th grade science class setting.

Questions this study is aimed to answer are as follows:

1. Is there a significant difference between experimental (PBL) and control groups' science achievement measured by Cell and Divisions Post Test?

2. Is there a significant difference between experimental (PBL) and control groups' retention of science learning measured by Cell and Divisions Retention Test?

Two hypotheses of this study are as follows:

$H_0$1: There is no significant difference between control and experiment groups in post-test Cell and Divisions Achievement Test scores.

$H_0$2: There is no significant difference between experiment and control groups in retention Cell and Divisions Achievement Test scores.

Variables of this study are as follows:

Independent variable: Independent variable of this study was the instruction type which were either the project based learning program or the traditional program.

Dependent variable: Dependent variable of this study was the academic achievement levels measured by Cell and Divisions Achievement Test. This was a quantitative variable.

3.3. Population and Sample

Population of this study involves all state middle schools located in Muğla. Accessible population has been set as students who are in Bodrum due to the scope of this study. Therefore, result of this study can be generalized to this accessible population.

Two middle schools were selected out of total 19 middle schools in Bodrum. This selection was made by convenient sampling. Researcher talked with one principal and he convinced another principal to join the study. Study has been carried out in Ortakent Kerem Aydınlar Middle School and Bitez Gülümser-Mehmet Danacı Middle School.

Ortakent Kerem Aydınlar Middle School is located distant to the settlement on a hilltop with 691 students and 30 teachers, including four science teachers and 26 classrooms. School facilities contain one science lab, two workshops, library and cafeteria. Bitez Gülümser-Mehmet Danacı Middle School is located in a populated residential area with 573 students, 35 teachers five of which being science teachers and 19 classrooms. School facilities contain a specialized music classroom, cafeteria and school yard. There are no operational science or computer labs in either schools.

In order to pick equivalent classrooms in terms of academic achievement, all classrooms' science notes from 2017-2018 Spring semester were compared with one way ANOVA. Classrooms with equal science achievement who were going to be taught by the same teacher were selected to be assigned into experimental and control groups. In the cases where there were more than two eligible classrooms, they were selected randomly. Selected classes were assigned into conditions randomly.

Four classrooms were assigned into control and experimental groups. In School A there were 31 students in experimental group (16 males, 15 females), and 30 students in control group (20 males, 10 females) In School B there were 30 students in experimental group (20 males, 10 females) and another 30 students in control group (18 males, 12 females). A total of 121 students were participated in this study. Their ages varied between 12 and 13.

3.4. Treatment

This study was performed in two middle schools located in Bodrum, Muğla in the Fall Semester of the 2018-2019 school year through six weeks. Four classes including 121 7th grade students participated to the study. One class in each school assigned into experimental or control groups. Control and experimental groups were taught by the same teachers in the schools. Experimental groups were taught in project based learning, while in control groups teachers used traditional methods.

Researcher met with teachers to introduce them with the PBL and the program designed for this study. Both teachers were contracted for one year of service in their respective schools. In School A, the teacher was a double major in both science and mathematics education. He had a total 3 years of experience -two years in science and one year in mathematics education- prior to the treatment. In School B, teacher had no previous experience prior to the study. Basic principles of the PBL, weekly plans and objectives were explained to and discussed with the teachers over one week. Weekly plans can be found on Appendix A. Treatment to the control group was also discussed and teachers were asked to utilize teacher-centered traditional

approach. Researcher attended the sessions with the experimental groups and assisted the teachers, when needed. To understand what happened in control groups, interviews with teachers were held after the study. Both teachers described similar classroom environments which utilized lectures, drawings and question-answer sessions led by the teacher. Homework was given occasionally.

As treatment in control group traditional teaching methods were utilized. Cell and Divisions unit was covered by the teachers using primarily lectures and explanations. Teachers introduced the topic of the day, used whiteboard to write or draw and important knowledge so that students can copy into their notebooks. Dictation was also often utilized. After lectures teachers asked questions regarding the subject. Tests were used as drills using both via smart board. Summaries were made at the end of the sessions. Homework was given in form of worksheets or teachers' request of studying the following topic.

In experimental group PBL program was used to teach the unit. At the first day the researcher introduced PBL method and the study to the students. Students formed six to seven groups of four to six people in accordance with the classroom size. In one school they picked their own groups and in other teacher had to form the groups. First driving question, which urged students to learn about cells "Can you design a cell model?" was given to the groups. Students had four sessions or approximately two weeks to finish their models. The evaluation criteria for their projects were:

- Model must show a real cell in either plant or animal organism, hypothetical cells are not accepted.
- Model must represent cellular structures (cell membrane, cytoplasm and organelles) of the selected cells.
- In the presentation of the projects, groups must share their knowledge on the cellular structures and tissue, organ and system of their cell.
- Projects must be finished in two weeks.

In the first session groups discussed which cell they wanted to model. They were also given a worksheet called "First Project Starting Form" to facilitate their thinking

on their models. The form inquired students on their projects' time table for matters like deciding which cell to model, research and production phases of the project. They were also asked about the resources they would use for research and their initial thoughts regarding their end-product. Both teacher and the researcher assisted groups to improve on their ideas and guided them to do their projects according to the project evaluation criteria based on students' initial thoughts expressed on the form. Also form reminded the groups their responsibilities to do their projects and to share videos of their progress.

Lastly, students were asked to post video logs which allowed researcher to track their progress and understanding. Video logs were one of the evaluation criterion and they had to be posted on the Facebook page of the study, all teachers and students in experimental groups were asked to join this group, so that they could see what other groups did and interact with each other. This session ended by reminding students that they should decide which cell they would model until the next session.

In the second session some groups were certain on what they want to do. They presented what cell they would model and why they picked it. Teacher gave feedback on which parts they should focus on and how to further improve the learning and the model. Other groups required assistance for their topic and teacher helped them to think few options. Classes were also shown internet resources that they can use for their research. In one school, library was utilized to start research. Teacher reminded students to continue their research until next session. Also group posted video logs on the webpage regarding their progress.

In the third session groups started to create their projects, lesson time was given to work on the projects. Teachers helped all groups to make progress in their projects and inquired them about their subject knowledge, in case of misconceptions or lack of knowledge they corrected students or directly taught about the topic.

In the last session, groups presented their projects and knowledge they gathered about their cells. Teacher further questioned the students to assess their knowledge level and built on it in some cases.

The second driving question which helped students to learn about mitosis was "Where do cells come from?" The learning process was similar to the first one in terms of introduction of the driving question, research phase, classroom environment and presentation of project; however for this project researcher also provided groups with petri dishes. Groups were asked to grow a bacteria culture in the dishes and write a report on their observations, bacteria growth, and possible explanations on what happened in the petri dish. Students had three sessions of time to complete their reports. Project requirements were as follows:

- Each group must grow a bacteria culture in their petri dishes
- Groups must upload a video log on how they started the culture, growth and their explanations about what is happening
- Studying cultures under the microscope (if school has suitable equipment)
- Writing a report of their findings. Reports must involve:
    1. Importance of mitosis for different organisms
    2. Reasons of mitosis
    3. Stages of mitosis
- Time limitations

Following the introduction of the driving question groups grew their bacteria cultures in the 2 to 3 days. Quick growth of the bacteria culture in the petri dishes opened a natural, curious discussion in classrooms on the second session which teachers had easy time leading into mitosis. Students were encouraged for further research. Reports were prepared during second week, turned in at the end and findings were discussed in the class with teacher's facilitation.

Last driving question was "What were you before you were human?" and it was aimed to investigate meiosis. Further liberty on this last project were given to students to increase their autonomy. Every project that explains the importance of the meiosis, how it happened, and its differences with mitosis was accepted.

Learning process was similar to the previous two projects in terms of decision and planning, research and production phases. Weekly plans and objectives for three sub-topics can be found in Appendix A.

The researcher was present in experimental groups' sessions throughout the treatment to introduce the study, observe the classroom and teacher and occasionally to assist instruction to keep the treatment PBL. Further feedback was given as the treatment progresses to teachers to maintain PBL frameworks. Although teachers did the instruction mainly, the researcher sometimes assisted for classroom management and talked with groups about their projects. At the end of the projects researcher gave feedback to the groups about their projects along with the teachers and on the Facebook group he interacted with students about their project progress. Lastly, bacteria growth experiment for the second driving question was demonstrated by the researcher.

A grading rubric was also utilized in this study to evaluate overall success of the experimental group in their tasks. Rubric graded projects for following qualities: required elements, comprehension, clarity and relevance, originality, attractiveness, oral presentation, accuracy/content knowledge, and final product. Students were also asked to create weekly video logs in timely manner to allow the researcher to track their progression on their projects. Videos enabled students to easily show their projects and efforts in a much effective way than a written or oral report. These video logs were also taken into consideration in grading projects, adding another item to the rubric. In total, 60 was the overall highest score achievable while 15 is the lowest. Groups were graded by the researcher.

3.5. Data Collection Instrument

The data to measure student performance at the end of intervention were collected through a tool called "Cell and Divisions Achievement Test" which was developed by the researcher to measure academic achievement levels of the participants. It is an 18 item test that comprises multiple selection items, fill in the blank items, short

answer items, true-false items and one drawing item. Maximum point that can be scored is 100. The test was shown to three science teachers, one of them with Master's Degree. All teachers agreed that the test comprises all the objectives and subject knowledge related to the unit. It was also stated that test might be difficult for some of the students, but that was a design feature as researcher wanted to assess the development of deeper knowledge and since every student was to take this test measurement errors that may arise assumed to be controlled.

Pilot study of this test could not be implemented reliably. The problem was Cell and Divisions unit's introduced into curriculum in 2018-2019 school year, at a time when intervention and data collection took place. The unit merges two units from the old curriculum, one from 6th grade level and another from 8th. So, in the start of the 2018-2019 school year there were no middle school students who has recently taken this unit and learnt all related objectives, only high school students were eligible for the pilots. Pilot study with high school students could not be carried out, for age difference and bureaucratic reasons. Pilot was executed with two 7th grade classrooms which would be excluded from the main study as eligible classsrooms, but they were only taught the content that was brought from 6th grade unit, thus resulting leaving the test mostly empty. Therefore, the results of this study should be treated with this limitation arising from using an unpiloted test for reliability. And this limitation was partially dealt with subjecting the test to expert review as explained above.

The achievement test is presented in Appendix B.

3.6. Data Collection Procedures

The achievement test was administered by the researcher three times to both control and experimental groups: prior to, at the end of, and one month later than the instruction. There were 6 weeks between pre and post test implementation. Testing took place between October and late December in 2018-2019 fall semester. Every

group took the test in their own classroom. 40 minutes were given to the students to finish their tests.

3.7. Data Analysis

All gathered data were transferred to computer environment and analyzed by using Excel and SPSS 23. To analyze the group differences in the achievement tests, descriptive statistics and independent group t-tests were used for pre-test, post-test and retention scores to compare the groups, separately for two schools. Also gain score differences were compared. Pre-test scores were subtracted from post-test scores for each participant and a new valuable was created as post-test gain score. Groups were compared by this new variable with t-test for gain score differences in school scale. Gain score differences between post-test and retention test scores were analyzed as well. Similarly, post-test scores were subtracted from retention scores and another valuable called retention gain scores was created. Groups were compared by this variable with t-test for gain scores in school scale.

3.8. Ethical Issues

Prior to the treatment, students' oral consent was taken by their teachers and their parents receieved informed consent forms which explains the study. Consent forms signed by parents were collected back. The form can be found in Appendix C. Prior to the study required ethical and bureaucratic clearances were obtained from Human Subjects Ethics Committee (HSEC) of METU (Appendix D) and Muğla Provincial Directorate for National Education (Appendix E) to guarantee conformity to the ethical guidelines and MoNE regulations. School principals and science teachers also inspected the program to avert any potential harm to the students and incongruousness to the national educational policies.

3.9. Threats to Internal Validity

There are threats to this study's internal validity. The biggest one is the difference between the groups in terms of the achievement level. Classrooms with equal science grades from 2017-2018 Spring semester were selected to participate in this study, however experimental and control groups scored significantly different in the pre-tests of this study in 2018-2019 Fall semester. In School A, control group achieved higher while in School B experimental group got better results.

Due to continuous and cumulative nature of the treatment and working with intact classrooms, mortality was the second important threat. Study started with 121 students. During the treatment and data collection processes, one student left the city, five missed the pre-test, five missed the post-test and 43 missed the retention test due to absenteeism. Retention was particularly affected by this especially in B because schools allowed the testing only after the end of school exams, a time when most student chose to not go to school.

Testing might have become a threat as groups took the achievement test three times. In order to reduce the threat to the minimum, researcher never talked about the tests and advised teachers not to as well. Since control groups were also utilized in the study, it can be claimed that testing effect was controlled. Other threats to internal validity appears to be neglectable.

3.10 Limitations

One of the limitations of this study is content coverage of 7th grade science curriculum. Due to limited time, resources, and scope of this study, content that was covered was limited with just one unit. As a result, teachers and students had relatively small amount of time to adjust into PBL. The number of schools and classrooms in this study were also limited to keep the study in manageable scope to the researcher.

Students were not assigned randomly to experimental and control groups, and this is a limitation of the study, therefore it should be treated as quasi-experimental study. In the school scale, they were selected based on their willingness to participate in the study however they were also among the schools with at least five 7th grade classrooms to help with choosing experimental and control groups at similar achievement levels. In classroom scale, as discussed earlier, there were two criteria that two classrooms needed to fulfill in order to be eligible as experimental and control groups. One was the equal science course achievement in the Spring 2017-2018 semester based on their GPAs, and the other was being taught by the same teacher in the Fall 2018-2019 semester. This created a constriction for the selection of classrooms. In School A all seven classrooms had similar science achievement levels, however there was only one teacher willing to participate in the study and he was assigned to two 7th grade classrooms. In School B only three out of five classrooms had science achievement levels and only two had the same teacher in the following semester. Thus, in both schools selection of classrooms for the study was not random, but once they were determined based on the above criteria, they were randomly assigned as experiemental and control groups.

3.11 Assumptions

The following assumptions were made in this study:

1. The differences among schools in terms of their facilities and student profile are not big enough to cause a difference in the results.
2. Students took the instruction both in experimental and control groups seriously to achieve higher achievement.
3. Students did not cheat during the exam.
4. Teachers were equally engaged in all four classrooms in line with the requirements of the intervention and traditional instructional processes.

CHAPTER 4

RESULTS

The purpose of this study was to investigate the impact of project based teaching and learning on students´ achievement in a unit of 7th grade science course through a control group quasi experimental study. First, pre-test results were presented, followed by analyses regarding the first and second research questions of the study were discussed. Descriptive statistics, t-tests and gain score differences regarding to their respective research questions were presented together.

4.1. Research Question 1: Is there a significant difference between experimental (PBL) and control groups' science achievement measured by Cell and Divisions Post Test?

In order to find whether there were any differences between groups prior to treatment, pre-test scores in the achievement test were investigated. In School A control group (*M*=8,56, *SD*=8,33) achieved higher than the experimental group (*M*=3,50, *SD*=2,57) in the pre-test. This difference was statistically significant (t=3,08, df=34,84, p<,05). In School B experimental group (*M*=6,31, *SD*=2,76) achieved higher than the control group (*M*=4,28, *SD*=3,49). According to t-test this difference was statistically significant as well (t=2,45, df=56, p<,05). Table 3 summarizes pre-test scores of each school. T-test results comparing group differences can be found in Table 4.

Table 3.

Students' Pre-test Results

Schools		N	Mean	Std. Deviation	Std. Error Mean
A	Control group	30	8,56	8,33	1,52
	Experimental group	28	3,50	2,57	,49
B	Control group	29	4,28	3,49	,65
	Experimental group	29	6,31	2,76	,51

Table 4.

Students' Pre-test t-test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
Schools		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
A	Equal variances assumed	19,48	,00	3,08	56	,00	5,06	1,64	1,77	8,35
	Equal variances not assumed			3,17	34,840	,00	5,06	1,60	1,82	8,30
B	Equal variances assumed	1,44	,24	2,45	56	,02	2,02	,83	3,68	,37
	Equal variances not assumed			2,45	53,204	,02	2,02	,83	3,68	,38

Post-test results were examined for schools individually. In School A control group (*M*=20,12, *SD*=8,76) achieved higher than experimental group (*M*=15,46, *SD*=8,19). This difference was statistically significant (*t*=2,07, *df*=55, *p*<,05). In School B experimental group (*M*=22,41, *SD*=8,80) achieved higher than control group (*M*=13,52, *SD*=8,11). According to t-test this difference was statistically significant (*t*=4,04, *df*=57, *p*<,05). Table 5 summarizes post test results in achievement test scores of the groups. Table 6 summarizes t-test results comparing the differences in achievement between experimental and control groups.

Table 5.

Students' Post-test Results

Schools		N	Mean	Std. Deviation	Std. Error Mean
A	Control group	28	20,12	8,76	1,65
	Experimental group	29	15,46	8,19	1,52
B	Control group	30	13,52	8,11	1,48
	Experimental group	29	22,41	8,80	1,63

Table 6.

Students' Post-test t-test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
Schools		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
A	Equal variances assumed	,05	,82	-2,07	55	,04	-4,66	-2,24	-,16	-9,16
	Equal variances not assumed			-2,07	54,431	,04	-4,66	-2,25	-,15	-9,16
B	Equal variances assumed	1,02	,32	4,04	57	,00	8,89	2,20	13,30	4,48
	Equal variances not assumed			4,03	56,244	,00	8,89	2,20	13,30	4,47

Next, gain score differences between pre and post test were analyzed. Pre-test scores were substracted from post-test scores for each participant and coded into a new valuable as post-test gain score difference. Then, groups were compared for this new value. In School A, experimental group (*M*=11,87, *SD*=8,19) achieved slightly higher than control group (*M*=11,78, *SD*=5,37), but difference was not statistically significant (*t*=,04, *df*=44,66, *p*=,96). In School B, experimental group (*M*=16,10, *SD*=9,43) achieved higher than control group (*M*=9,36, *SD*=7,76) and according to

t-test it was a statistically significant one (*t*=2,97, *df*=56, *p*<,05). Descriptive data of gain scores can be found on Table 7, while t-test results are summarized in Table 8.

Table 7.

Students´ Post-test Gain Score Differences

School		N	Mean	Std. Deviation	Std. Error Mean
A	Control group	28	11,78	5,37	1,01
	Experimental group	27	11,87	8,19	1,57
B	Control group	29	9,36	7,76	1,44
	Experimental group	29	16,10	9,43	1,75

Table 8.

Students' Post-test Gain Score Differences t-test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
Schools		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
A	Equal variances assumed	4,24	,04	,04	53	,96	,08	1,86	3,82	3,65
	Equal variances not assumed			,04	44,664	,96	,08	1,87	3,86	3,69
B	Equal variances assumed	,80	,37	2,97	56	,00	6,74	2,27	11,28	2,20
	Equal variances not assumed			2,97	53,992	,00	6,74	2,27	11,29	2,20

4.2. Research Question 2: Is there a significant difference between experimental (PBL) and control groups' retention of science learning measured by Cell and Divisions Retention Test?

In order to answer the second research question, retention scores in the achievement test were analyzed. In School A control group (*M*=22,92, *SD*=10,31) achieved higher than the experimental group (*M*=17,64, *SD*=9,18). But difference was not significant

statistically (*t*=,37, *df*=51, *p*=,06). In School B experimental group (*M*=28,59, *SD*=8,62) achieved higher than the control group (*M*=15,69, *SD*=7,36). According to t-test difference was statistically significant (*t*=3,88, *df*=23, *p*<,05). Table 9 summarizes descriptive data and Table 10 summarizes t-test results.

Table 9.

Students' Achievement Retention Test Results

Schools		N	Mean	Std. Deviation	Std. Error Mean
A	Control group	29	22,92	10,31	1,91
	Experimental group	24	17,64	9,18	1,87
B	Control group	17	15,69	7,36	1,78
	Experimental group	8	28,59	8,62	3,05

Table 10.

Students´Retention Test t-test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
Schools		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
A	Equal variances assumed	,81	,37	1,95	51	,057	5,27	2,71	,16	10,72
	Equal variances not assumed			1,97	50,697	,054	5,28	2,68	,10	10,66
B	Equal variances assumed	,43	,52	3,88	23	,001	12,90	3,33	19,79	6,02
	Equal variances not assumed			3,65	12,007	,003	12,90	3,53	20,59	5,21

Then, gain score differences between post-test and retention test was analyzed. Similar to the previous analysis, a new variable was created by subtracting post-test scores from retention scores. Then difference in terms of this variable was compared

for experimental and control groups for schools data using t-test for independent groups. In School A, control group's gain score (*M*=2,95, *SD*=4,66) was higher than of the experimental group's (*M*=1,27, *SD*=4), but this difference was not significant (*t*=,17, *df*=49, *p*=,17). In School B, however, experimental group's gain score was (*M*=3,62, *SD*=2,82) higher than of the control group's (*M*=,97, *SD*=2,94) and difference was statistically significant (*t*=2,13, *df*=23, *p*<,5). Descriptive data of gain scores can be found on Table 11, while t-test results are presented in Table 12.

Table 11.

Students´ Retention Gain Score Differences

Schools		N	Mean	Std. Deviation	Std. Error Mean
A	Control group	27	2,95	4,66	,9
	Experimental group	24	1,27	4	,82
B	Control group	17	,97	2,94	,71
	Experimental group	8	3,62	2,82	1

Table 12.

Students' Retention Gain Score Differences t-test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
Schools		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
A	Equal variances assumed	,76	,39	1,37	49	,18	1,68	1,22	-,78	4,14
	Equal variances not assumed			1,39	48,946	,17	1,68	1,21	-,75	4,12
B	Equal variances assumed	,02	,88	-2,13	23	,04	-2,65	1,24	-5,23	-,08
	Equal variances not assumed			-2,17	14,352	,05	-2,65	1,22	-5,28	-,03

To summarize the results, pre, post, retention tests and respective gain score differences were examined at school level. Analyses showed that there were significant differences in pre-tests in School A in favor of the control group and in School B in favor of the experimental group. After treatment, in School A control group achieved significantly higher in the post-test compared to the experimental group. However no significant differences were observed in retention test results and gain score results. On the other hand, in School B, experimental group achieved significantly higher than the control group in the post-test and the retention test, and this difference was also evidenced through gain scores in both groups.

CHAPTER 5

CONCLUSIONS AND IMPLICATIONS

This chapter starts with summary of the research, then results are discussed in relation to theoretical framework and previous research and finally implications for practice and further research are offered.

5.1. Summary of the Study

This purpose of this study is to investigate the effect of project based teaching and learning on students´ achievement in a unit of 7th grade science course through a control group quasi experimental study. Study started with review of literature followed by designing main purpose of the research and research questions. Then, Cell and Divisions Achievement Test was created. Following that, project driving questions and criteria for projects were designed, weekly lesson plans were created. Cell and Divisions Achievement Test was reviewed by peer teachers. Two schools were volunteered for the study in Bodrum. Pilot studies were carried out with 2 classrooms that would not take place in the main study.

Two intact classrooms from each school, consisting of 121 7th grade students who were taught by the same teachers, were selected for their similar average science achievement and assigned into control and experimental groups randomly. In the fall semester of 2018-2019 academic year, experimental groups were instructed with PBL program while control groups were subjected to a traditional instruction in Cell and Divisions unit. Students in the experimental classrooms were asked to form groups and carry out three special tasks, projects, for each sub-topic of the unit while

students in the control group experienced more teacher-centered lecture, presentation and drilling sessions.

Cell and Divisions Achievement Test was administered three times: prior to the start of the unit, immediately after the instruction of the unit and one month after the instruction. Experimental groups were also graded for their projects with Grading Rubric for each of their projects. Data were analyzed with independent samples t-test to compare experimental group with the control group for their pre-test, post-test and retention test scores in each school separately. Significant differences existed between the two groups in individual schools, in one favoring the experimental groups and in another favoring control group, leading the researcher to analyze gain score differences between pre-test and post-test as well as between post-test and retention-test using t-test for independent groups. As discussed under the limitations, the significant differences between experimental and control groups in individual schools at pre-tests could pose an internal validity threat.

As discussed earlier a grading rubric was used in the treatment phase to infer project groups' overall success in creating projects. Groups' success rates on their projects show that two schools had different achievement rates. Comparison in terms of project grades indicate project groups in School A achieved higher than those who were in School B. When transformed into 100 standard point from the rubric's original 60 maximum points for convenience, for the first, second and third project average grades for School A experimental group were 58,88, 67,21 and 68,77 respectively. For School B on the other hand, average grades were 47,92, 40,54 and 55,63. The difference was partly due to two factors: overall performance and admission rates of the groups. Groups that were able to present a valid project which satisfies the required criteria achieved higher in School A and lower in School B. However, submission rates also played a role in these results. In School A, 5 groups were not able to submit their projects and scored 0. In School B, 8 groups failed to present any project throughtout the instruction. It should be noted though, these results are calculated for each class cumulatively. In every school there were groups who consistently managed to submit valid projects. Standard deviation values like

15,69 or 22,35 show there were considerable differences between project groups in both schools.

5.2. Discussion of Results

In pre-test scores school data indicate that every control group was statistically different than its experimental counterpart. In School A control groups achieved higher than experimental groups, while in School B experimental group scored higher than control group. This difference most likely was caused by previous knowledge which students had as the new Cell and Divisions unit is based on the old 6th grade cells unit. Since there was no control over students' previous learnings and intact groups were used, gain score differences were added to the analyses.

In post-test scores however, experimental group achieved significantly higher than the control group in School B. In School A however control group achieved higher than experimental group in post-test. However, since groups were not equal at the first place, gain score differences were also analyzed. Still, it yielded somewhat similar results. Although experimental groups' gain scores were higher in both schools, it was only significant in School B. In School A, no significant difference was observed between experimental and control group. This finding likely means the differences between these two groups in School A can be attributed to the other factors such as student readiness, rather than the treatment. Briefly, first hypothesis of the research was rejected in one school and accepted in another. Thus, school based data shows that treatment may have affected schools differently. In School A, control group achieved higher than experimental group at almost every test and their gain scores were equal. So judging by data, it can be said that treatment was not effective in this school. On the other hand in School B, the PBL program was effective in causing higher level of achievement judging by the group differences in terms of post-test, retention test scores and gain score differences.

Retention tests were also conducted one month after the end of instruction. However, schools asked researcher to administer retention tests after final examinations of the

semester, so participants of the retention tests were relatively smaller in numbers since some students decided not to go to schools after examinations. In School B experimental group scored higher than their control counterparts. In School A control group scored considerably higher than the experimental group and although t-test results were very close to the cut-off point, *p* value was higher than, 05, so no significant difference was observed. Thus, second hypothesis of the study was rejected for School B and accepted for School A. However it should also be noted that 43 participants could not participate the retention test and this might have altered the results. Scores changed but not significantly, this can also be attributed to testing effect, since student took the test two times before.

Data suggested mixed results in two schools in terms of post-test achievement. However, findings favored PBL more than traditional instruction as results from School B suggested that PBL is capable of good performance in summative testing, and retention judging by significantly outscoring control group in post-test, retention test, and gain scores. Also, except in post-test, control group in School A did not score significantly higher than experimental group in retention and gain score analyses. So, effectiveness of PBL compared to more traditional instruction approaches in terms of achievement is coherent with PBL literature in Turkey and the world in science education (Baş, 2011; Bilgin, Karakuyu & Ay, 2015; Ergül & Kargın, 2014; Holmes & Hwang, 2016; Karaçallı & Korur, 2014; Mioduser & Betzer, 2008; Schneider, Krajcik, Marx & Soloway, 2002; See, Rashid & Bakar, 2015). However, seemingly there are some prerequisites to be fulfilled in order to implement PBL more successfully. It is thought that the most important prerequisites are skilled teachers and the environment they created in classrooms. Classroom experience could be a highly influential variable. It is widely accepted that teachers who have practice time of three years or less are novice teachers, while four years or more means career teachers (Tschannen-Moran & Hoy, 2007). Although PBL was new to both teachers who participated to this study, teacher in School A had three years of experience while teacher in School B had none. Furthermore, teacher in School A was a double major both in science and mathematics education which might indicate his education was more extensive and rigorous. This might have

influenced the achievement of control groups particularly because what they are experienced at -or not experienced at- is teaching traditional classrooms. For experimental groups, on the other hand, according to researcher's observations, teacher in School B was much more involved with students in terms of feedback and suggestions than teacher in School A. She closely inspected their progression, went group to group at classroom sessions, talked with groups, guided those who were confused or whose progression was stalled due to any reasons and offered suggestions. In School A however, teacher was less involved and preferred to stay back and give students more freedom and less structure and feedback. This might have backfired as research shows importance of feedback, especially when students are given chance to do something by themselves (Hattie & Timperley, 2007; Shute, 2008). Especially when using methods such as PBL students may feel lost due to doing something new and unknown to them, so feedback and guidance is extra effective under such settings.

Another prerequisite can be school facilities and overall access to knowledge. PBL is supposed to take place in a knowledge rich environment and supported by technology to engage harder activities than they can do by themselves (Blumenfeld et al., 1991). However, only one school had a library with old encyclopedias and neither had a computer lab with internet access. If there were computer labs, sessions were planned to be held in computer labs for better access to knowledge along with a quick training to find reliable knowledge online. This seriously hindered students' ability to look for answers, discover, and get inspired by similar works. Main knowledge sources for students were their textbooks, teachers and researcher who provided them with relevant knowledge or graphics found online such as cell photographs or useful links. Library in School A was utilized and engaged students to research and learn, however due to limited scope of encyclopedias and missing fascicules, its contribution was limited. Internet access, availability of databases and information resources and laboratories can be extremely useful to structure the learning environment. Also classrooms were consisted of around 30 students which proved hard for teacher to facilitate. It is thought that PBL would prove more successful in classrooms with not more than 20 students especially in elementary and

middle school settings for better teacher support and classroom management. Assistant teachers can be useful for bigger classrooms.

Working as groups instead of individuals might be another factor between groups. As stated earlier, while creating the groups teachers helped their students so that there is at least one person who can help their friends with learning objectives and managing the process. Vygotsky's zone of proximal development can be used to explain the situation. These more capable students might be improving their peers' knowledge as they cooperate with them. On the other hand, in the cases where groups could not submit their projects, reason was mostly conflicts within group members, mostly not doing their part of the work or not being able to meet with other members to complete relatively harder tasks.

Another interesting finding was the gain scores observed in post-test and retention tests in School B. Compared to School A, experimental group in School B scored significantly higher on post, retention and both gain score tests but scored lower in their projects. As mentioned earlier, there are some evidence suggesting low achievers enjoys a higher rate of growth from PBL (Barron et al., 1998; Doppelt, 2003, Han, Capraro & Capraro, 2015; Halvorsen, et al., 2012; Marx, et al., 2004; Mehalik, Doppelt & Schunn, 2008). Although it is not reliable to brand students in School B as low achievers since this study did not aimed to seek such difference, experimental group in School B consistently got lower scores in their projects, also teacher also taught that they were below average. So, although evidence is indirect, experimental group in School B may be low-achievers. If that was indeed the case, that would be congruent with some empirical studies regarding low achievers enjoying a higher rate of growth from PBL.

5.3. Implications for Practice

According to the findings of this study following implications are proposed in respect to curricular, educational or learning applications:

- Findings of this study suggest PBL can be beneficial in middle school science education. Recent changes in curriculum in Turkey shows projects will have increasing importance. So results of this study can be insightful to new curricula efforts, such as design of new educational materials.
- PBL programs should be structured extensively to not allow any kind of confusion for teacher and students.
- Teachers should be trained extensively to implement constructivist programs theoretically and practically. Using PBL in specific, and constructivist methods in general, in the classroom is still a rare skill for most teachers, attention from pre-service and in-service teacher education programs is needed to help teachers improve themselves in these methods. Teachers in this study was not experienced with PBL and such training may further improve the results and achievement of the students.
- Another challenge was the difficulty to access information in school apart from textbooks and teachers. As curriculum gets more constructivist so should the school facilities. However no schools had a computer laboratory and only one of them had a library which proved difficulties in treatment. Equipping schools with information technologies would improve the methods such as PBL.

5.4. Implications for Further Research

According to the findings of this study following implications are proposed for further studies:

- This study investigated PBL in single grade level and unit. Effectiveness of PBL can be investigated for different grades and broader curricular topics. Longitudinal research can be carried out with larger and more diverse sample. Whether using methods that involves student inquiry have beneficial long term effects in terms of cognitive, intrapersonal and interpersonal skills should be further investigated.

- Role of PBL or similar methods in gaining better use of knowledge, extrapolation, and acquisition of deep knowledge should be investigated. Studies which use PISA results in relation with instruction can be of use in this regard.
- Question types that are easier or harder to answer for PBL students can be investigated to understand how PBL facilitates learning better.
- PBL can be investigated with the presence of tools that enable immediate access to information. Utilization of internet access or predetermined databases and resources in PBL implication may prove useful.
- Role of PBL in the growth of low, medium and high achievers can be investigated. Schools in this study affected differently by the treatment. The reason why some students/schools benefit more than others should be investigated.
- Teachers participated in this study had little to no experience with PBL, so method can be examined with trained and experienced teachers.
- Testing might be a treat to this study's validity, using equal tests instead of same test double or triple may prove more reliable data.
- This study only evaluated PBL by the achievement test results, however a broader set of evaluation, such as observations or qualitative studies will complement the results.

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APPENDICES

A. WEEKLY PLANS FOR TEACHERS

1. Konu: Hücre

Uygun ortam: (Varsa) bilgisayar laboratuvarı

Yönlendirici soru: Gerçek bir hücre modeli tasarlayabilir misiniz?

Süre: 7 ders saati

Beklenen proje: Çok hücreli bir canlı hücresinin modelinin öğrencilerin seçeceği şekilde oluşturulması ve modelin sunularak açıklanması

Projenin taşıması gereken nitelikler:

- Gerçek bir canlı hücresinin modeli olması
- Hücrenin hücre zarı, hücre çeperi, sitoplazma ve çekirdeğini doğru temsil edilmesi
- Sunumda hücre zarı, organeller ve çekirdeğin işlevleri ve hücrenin temel işlevi hakkında bilgi verilmesi
- Sunumda hücrenin içinde bulunduğu doku, organ ve sistemin belirtilmesi
- Zaman sınırlamasına uyulması

<u>Ders Planları</u>

1. ders (1. ve 2. ders saati)

- Öğrencilere proje tabanlı öğrenme hakkında bilgi verilir Bu bilgiler şunları içermelidir:

1. Öğrenciler ders içeriğini, yönlendirici soruları cevaplamaya ve projelerini beklenen hale getirmeye çalışırken öğrenirler.

2. Araştırmalarını yürütmek ve projelerini hazırlamak öğrencilerin sorumluluğundadır.

3. Öğretmen onların yardımcısı, rehberi olur ve projelerinin daha iyi planlanmış, faydalı ve öğretici olması için çalışma rolü üstlenir.

- "Hücre ve Bölünmeler" konusunu öğrenmek için 3 farklı soruyu cevaplayıp beklenen özellikleri sağlayan projeler üretmeleri beklenecektir. İlk soru "Gerçek bir hücre modeli tasarlayabilir misiniz?"dir. Öğretmen projenin taşıması gereken yukarıda belirtilen özelliklerini öğrencilerle paylaşır.
- Öğretmen grupların haftalık ilerlemeleri hakkında en fazla 5 dakikalık videolar çekip araştırmacının gösterdiği ortama dersten en geç bir gün önce yüklemeleri gerektiğini bildirir.
- Öğrencilerin en fazla 4 kişilik gruplara ayrılmaları istenir.
- Öğrencilerden 'Birinci Proje Başlangıç Formu'nu doldurmalarını istenir. Öğretmen gruplara projelerini somutlaştırmaları için yardımcı olur. Bu aşamada daha önemli olan öğrencilerin somut şekilde planlarını tamamlamalarından çok, proje tabanlı öğrenme yöntemi hakkında anlayış kazanmaları ve projelerinin tamamlanması için önem taşıyan araştırma, planlama, görev dağılımı ve son ürün hakkında düşünmelerini başlatmaktır.
- Öğretmen öğrencilere bir sonraki derse kadar projelerini kesin olarak belirlemeleri gerektiğini bildirir.
- Öğretmen öğrencilerin araştırmalarında kullanabileceği bazı kaynakları tanıtır.

2. ders (3. ve 4. ders saati)

- Öğrencilerin yükledikleri videolar üzerinden konuşulur. Gruplar sırayla projeleri hakkında detayları paylaşırlar. Öğretmen kendi geri bildirim ve destek verir; ayrıca öğrencilerin bilgilerinin doğruluğuna, kapsamına ve kullandıkları kaynakların güvenilirliğine dikkat eder. Aynı zamanda tüm

sınıfın da paylaşılan projeler hakkında yorumda bulunmasını ve sorular sormasını cesaretlendiren bir ortam oluşturur.

- Bu ders sonunda gruplar hangi hücreyi inceleyeceklerine, araştırma kaynaklarına, takvimlerine, görev paylaşımlarına ve projelerinin son halinin nasıl olacağına karar vermelidirler.

3. ders (5. ve 6. ders saati)

- Öğrencilerin yükledikleri videolar üzerinden konuşulur. Gruplar sırayla projeleri hakkında detayları paylaşırlar. Öğretmen kendisi projelere geri bildirim ve destek verdiği gibi tüm sınıfın da paylaşılan projeler hakkında yorumda bulunmasını ve sorular sormasını cesaretlendiren bir ortam oluşturur.
- Öğrenciler gruplar halinde projeleri üzerinde çalışırlar ve gruplar birbirleriyle fikir alışverişi yapar ve birbirlerinin projelerini inceler.
- Bu dersin sonunda gruplar projelerine yönelik araştırmalarını bitirmiş olmalı ve modellerini inşa etme aşamasına geçmelidirler.

4. ders (7. ders saati)

- Gruplar sırayla modellerini sınıfa sunarlar. Sunumda hangi canlının hangi hücresini modelledikleri, hücrenin yapısal özellikleri, işlevi, organellerinin işlevleri, hücrenin içinde bulunduğu sistem, organ, doku hakkında bilgileri paylaşırlar. Sunumlar 15 dakikayı aşmayacak şekilde yapılmalıdır. Sınıf ve öğretmen projelere geri bildirimde bulunur, yorumlar yapar, sorularını sorarlar. Öğretmen sınıfta hücreye dair ortak bir anlayış oluştuğundan emin olur, gerekli yerlerde sunum yapan gruplara sorular sorar.
- Öğretmen rubrik vasıtasıyla sunumları ve projeleri puanlandırır.

2. Konu: Mitoz

Uygun ortam: (Varsa) bilgisayar laboratuvarı

Yönlendirici soru: Hücreler nereden gelir?

Süre: 6 ders saati

Beklenen proje: Petri kabında bakteri kültürü büyütmek, gerçek veya sanal kaynaklar vasıtasıyla mitoz bölünmeyi gözlemlemek ve rapor oluşturmak

Projenin taşıması gereken nitelikler:

- Her grubun kendilerine verilen petri kabında bakteri kültürü oluşturması
- Grupların izledikleri yöntem ve gözlemleri hakkında video yüklemesi
- Eğer okulun imkanı varsa, grupların yetiştirdikleri kültürleri mikroskop altında incelemesi ve hücre bölünmesini gözlemlemeleri. Eğer okulun imkanı yoksa öğrenciler sanal laboratuvarı uygulamaları ve görsel materyaller kullanacaklardır.
- Grupların laboratuvarı gözlemleri ve araştırmaları sonucuna yeni hücrelerin nasıl oluştuğuna dair aşağıdaki ölcutleri sağlayan bir rapor hazırlamaları
    - Mitoz bölünmenin farklı canlılar için önemi
    - Mitoz bölünmenin nedenleri
    - Mitoz bölünmenin süreci ve evreleri
- Projenin zamaninda teslim edilmesi

<u>Ders Planları</u>

1. ders (1. ve 2. ders saati)

- Öğretmen yeni soruyu ve öğrencilerden beklenen projeyi tanıtır.
- Öğretmen petri kabı ve besleyici agar kullanarak nasıl bakteri kültürü oluşturacaklarını gösterir.
- Öğretmen gruplara bir sonraki derse kadar petri kaplarında kendi bakteri kültürlerini üretmelerini ve yöntemlerine ve gözlemlerine dair video yüklemelerini hatırlatır.

2. ders (2. ve 3. ders saati)

- Öğrencilerin yükledikleri videolar üzerinden konuşulur. Öğretmen geri bildirim ve destek verir ve tüm sınıfın tartışmaya katılması cesaretlendiren bir ortam oluşturur.

- Öğretmen tartışmanın odağını hücrelerin nereden geldikleri, nasıl çoğaldıkları konusunda tutar, öğrencilerin kendi hipotezlerini oluşturmaya yönlendirir.
- Öğretmen öğrencilerin araştırmalarında kullanabilecekleri bazı kaynakları öğrencilere tanıtır.
- Grupların bir sonraki derse kadar mitoz bölünme konusunda araştırma yapmaları ve videolar yüklemeleri istenir.

3. ders (4. ve 5. ders saati)

- Öğrencilerin yükledikleri videolar üzerinden konuşulur. Öğretmen geri bildirim ve destek verir ve tüm sınıfın tartışmaya katılması cesaretlendiren bir ortam oluşturur.
- Öğretmen öğrencilerin mitoz bölünme konusundaki bilgilerini ortaya çıkarmak için mitoz bölünmenin amacı, önemi ve sürecine dair sorular sorar, öğrencilerin kendi bilgilerini ve arkadaşlarının bilgilerini test etmeleri için gerekli düşünme ortamını oluşturur. Grupların muhtemel yanlış fikirlerinin ortaya çıkıp düzeltilmesi için imkan oluşturur.
- Öğrenciler gruplar halinde projeleri üzerinde çalışırlar ve gruplar birbirleriyle fikir alışverişi yapar ve birbirlerinin projelerini inceler.

4. ders (6. ders saati)

- Gruplar raporlarını birbirlerine sunarlar ve projeleri hakkında konuşurlar.
- Sunumlar 15 dakikayı aşmayacak şekilde yapılmalıdır. Sınıf ve öğretmen projelere geri bildirimde bulunur, yorumlar yapar, sorularını sorarlar. Öğretmen sınıfta hücreye dair ortak bir anlayış oluştuğundan emin olur, gerekli yerlerde sunum yapan gruplara sorular sorar.
- Öğretmen rubrik vasıtasıyla sunumları ve projeleri puanlandırır.

3. Konu: Mayoz

Yönlendirici soru: İnsan olmadan önce hangi evrelerden gectik?

Süre: 7 ders saati

Yer: (varsa) bilgisayar laboratuvarı

Beklenen proje: Grupların seçeceği herhangi bir şekilde mayoz bölünme konusunu açıklayan bir proje üretmesi.

Projenin taşıması gereken nitelikler:

- Mayozun önemini açıklaması
- Üreme hücrelerinde mayozun nasıl gerçekleştiğini göstermesi
- Mayoz ve mitoz bölünmenin farklarını göstermesi
- Projenin vaktinde teslim edilmesi

Ders Planları

1. Ders (1. ve 2. ders saati)

- Öğretmen yeni projeyi tanıtır, grupların yapabileceği birkaç proje örneği gösterir.
- Gruplar "Üçüncü Proje Başlangıç Formu"nu doldururlar, öğretmen grupların fikirlerini somutlaştırmaları için onlara yardımcı olur. 1. projeyle benzer şekilde burada da önemli olan hemen somut planlar çıkarmak yerine, grupların düşünmeye başlamasıdır.
- Gruplara bir sonraki derse kadar konu hakkında araştırma yapmaları hatırlatılır. Yüklenecek videolarda mayoz bölünme konusu hakkında özet bilgilerin olması istenebilir.

2. Ders (3. ve 4. ders saati)

- Grupların yükledikleri videolar üzerinden konuşulur. Öğretmen tüm sınıfın katılacağı bir tartışma ortamını kurmaya çalışır ve öğrencilerin konu

hakkındaki anlayışlarını ortaya çıkarmaya uğraşır, yanlış fikirlerin düzeltilmesine yardımcı olur.

- Öğrenciler projeleri üzerinde düşünürler.
- Bu dersin sonunda grupların araştırma süreçleri, proje olarak ne yapacakları, görev dağılımları kesin şekilde belirlenmiş olmalıdır.
- Öğretmen projelerin zorluk derecesi ve öğreticilik değerini değerlendirerek gruplara destek sağlar.

3. Ders (5. ve 6. ders saati)

- Öğrencilerin yükledikleri videolar üzerinden konuşulur. Öğretmen geri bildirim ve destek verir ve tüm sınıfın tartışmaya katılması cesaretlendiren bir ortam oluşturur.
- Gruplar projeleri üzerinde çalışırlar ve birbirlerinin projelerini gözlemlerler.

4. Ders (7. ders saati)

- Gruplar projelerini arkadaşlarıyla paylaşırlar. Sunumlar 15 dakikayı aşmayacak şekilde yapılmalıdır. Sınıf ve öğretmen projelere geri bildirimde bulunur, yorumlar yapar, sorularını sorarlar. Öğretmen sınıfta hücreye dair ortak bir anlayış oluştuğundan emin olur, gerekli yerlerde sunum yapan gruplara sorular sorar.
- Öğretmen rubrik vasıtasıyla sunumları ve projeleri puanlandırır.

B. CELL AND DIVISIONS ACHIEVEMENT TEST
(HÜCRE VE BÖLÜNMELER BAŞARI TESTİ)

Bu test Hücre ve Bölünmeler ünitesine dair bilgilerinizi ölçmeyi hedeflemektedir. Testi dersin sonuna kadar cevaplamanız gerekmektedir. Çoktan seçmeli sorular 1 puandır, diğer soruların puan değerleri de soruların yanında yazmaktadır. Çalışmaya katıldığınız için teşekkür ederim.

Adınız ve Soyadınız:

Okul numaranız:

1. **Şekilde verilen hücrelerle ilgili olarak aşağıdakilerden hangisi yanlıştır?**

A) II bitki hücresidir.

B) I de kofullar küçük ve çok sayıda olur.

C) I de bulunan kloroplast II de bulunmaz.

D) II de bulunan hücre duvarı I de bulunmaz.

2. Fen Bilimleri öğretmeni tahtaya kromozom sayılarının yer aldığı aşağıdaki tabloyu yansıtmıştır.

Canlı	**Kromozom sayısı**
İnsan	46
Eğrelti otu	500
Köpek	78
Moli balığı	46

Tabloya göre aşağıdakilerden hangisi söylenebilir?

A. Kromozom sayısı en fazla olan eğrelti otu, en gelişmiş canlıdır.

B. Canlıların kromozom sayıları ile gelişmişlik düzeyleri arasında bir ilişki yoktur.

C. İnsan ile moli balığının kalıtsal özellikleri aynıdır.

D. Kromozom sayısı arttıkça gelişmişlik düzeyi artar.

3. "Yaralandığımızda yaraların iyileşmesi, ... sonucu gerçekleşir."
Cümlesinde boş bırakılan yere aşağıdaki ifadelerden hangisi gelmelidir?

A) Adaptasyon B) Mutasyon C) Mayoz D) Mitoz

4. Mitoz bölünmenin ;
I.Üreme
II.Büyüme
III.Canlıların çeşitliliği

Verilenlerden hangilerinin gerçekleşmesinde etkisi yoktur?

A) Yalnız I B) I ve II C) Yalnız III D) I ve III

5. **Canlılarda gerçekleşen mitoz bölünmeler yardımıyla aşağıdakilerden hangisi yapılamaz?**

A) Yaralanan derinin zamanla iyileşmesi
B) Tohumun çimlenerek genç bitkiyi oluşturması
C) İnsanın doğduktan sonra zamanla ağırlığının iki katına çıkması
D) Vücudun süt, ter ve göz yaşını üretmesi

6. Fen Bilimleri dersinde mitoz bölünmenin evreleriyle ilgili bazı öğrenciler aşağıdaki açıklamaları yapmış fakat bazı bölümleri boş bırakmışlardır.

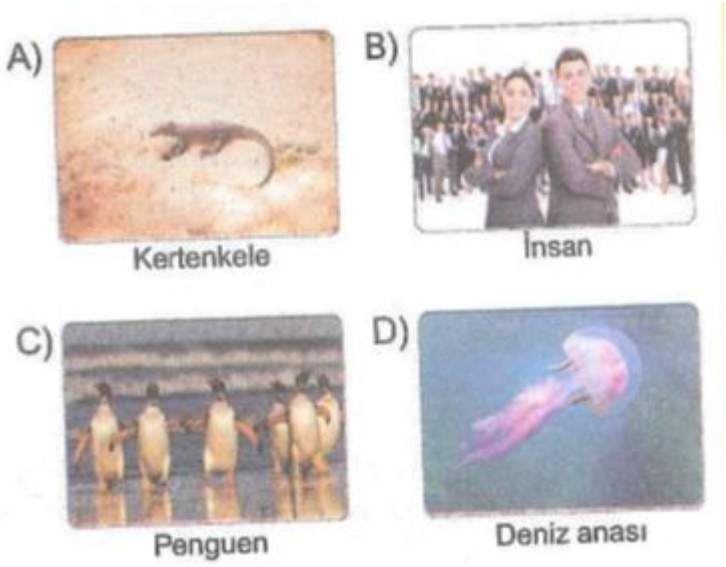
Özge: Kromozomların hücrenin ortasına dizildiği evre …… evredir.

Ege: Hücrelerin boğumlanmasının tamamlanarak bölündüğü evre …….. evredir.

Buna göre, öğrencilerin boş bıraktığı bölümlere sırasıyla aşağıdakilerden hangisi yazılmalıdır?

A. 1 - 3 B. 2 – 4 C. 1 – 2 D. 3 - 4

7. **Aşağıdaki canlıların hangisinde mayoz bölünme görülmez?**



8. **Mayoz bölünme sonucu yavrularda görülen kalıtsal çeşitliliğin temel sebebi aşağıdakilerden hangisidir?**

A. Bölünmenin başında hazırlıkk evresinin yaşanması

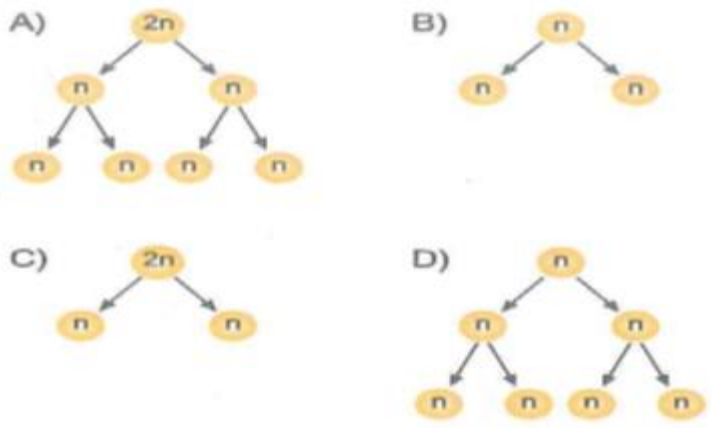
B. Kromozomlar arasında parça değişiminin gerçekleşmesi

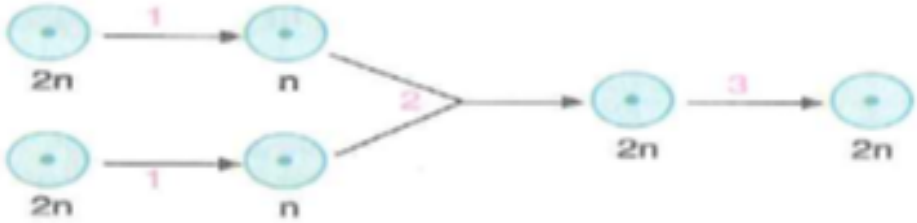
C. Eşey ana hücrelerinde meydana gelmesi

D. Çok sayıda evreden oluşması

9. Ahmet mayoz bölünmeyi anlatan bir şema hazırlamak istemektedir.

Buna göre, Ahmet aşağıdaki şemalardan hangisini hazırlarsa doğru olur?





10. Yukarıdaki şekilde “2n” kromozomlu hücrelerden yeni canlı oluşumuna kadar meydana gelen olaylar numaralarıyla gösterilmiştir.

Buna göre, numaralandırılmış olaylarla ilgili;

I. 3 numaralı olay, mitoz bölünmedir.

II. 1 numaralı olayda kromozom sayısı yarıya inmiştir.

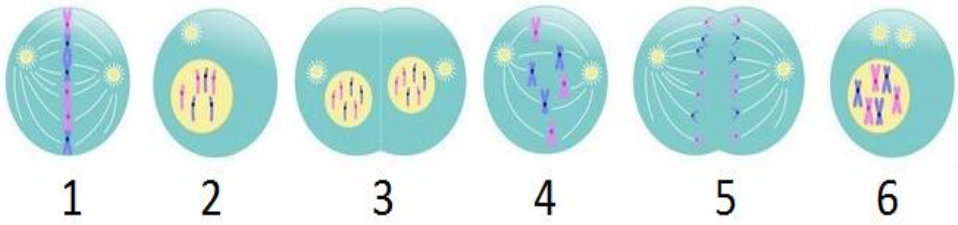
III. 2 numaralı olay, döllenmedir.

yukarıdakilerden hangileri söylenebilir?

A. Yalnız I B. I ve II C. II ve III D. I, II ve III

11. I. Üreme hücrelerinin oluşmasını sağlar.
II. Büyüme ve onarımda görev alır.
III. Kalıtsal çeşitlilik sağlar.

Yukarıdaki özelliklerin hangisi veya hangileri mayoz bölünmenin özelliğidir?
A) Yalnız I B) Yalnız II C) II ve III D) I ve III



12. **Yukarıda mitoz bölünme yapan bir hücrenin geçirdiği evreler karışık bir sırayla verilmiştir. Sayıları mitozun evrelerini doğru şekilde gösterecek şekilde sıralayın.** (3 puan)

13. **Aşağıdaki ifadelerin doğru veya yanlış olduğuna karar verin, eğer ifade yanlışsa altına doğrusunu yazın.** (her madde 1 puan)

a. …….. Hücreleri mayoz bölünme geçiremeyen bir insanın çocukları olabilir.

b. …….. Mayoz bölünme eşeysiz üreyen canlılarda üreme hücrelerinin oluşumu için kullanılır.

c. …….. Mayoz bölünme sonucunda 4 yavru hücre oluşur.

d. ……. Mayoz bölünmede oluşan yavru hücreler ana hücrenin birebir kopyasıdır.

e. ……. Mayoz I sonucunda n kromozomlu iki hücre oluşur.

f. ……. Tek hücreli mikroorganizmalar mitoz bölünme ile çoğalır.

g. ……. Çok hücreli canlılarda tüm hücreler mitoz bölünme yapabilirler.

h. ……. Mitoz bölünmenin ikinci evresinde kromozomlar ayrılarak kutuplara çekilirler.

i. ……. Mitoza hazırlık aşamasında hücre büyür ve DNA'nın kopyasını oluşturur.

j. ……. Mitoz geçiren bir hücrede sentrozomlar hücre kutbuna gitmişlerse, bu hücre bir bitki hücresidir.

14. **Boşlukları uygun sözcüklerle doldurunuz.**

Görevlerinden biri hücrenin dış etkilerden korunmasını sağlamak olan …….nın başka iki görevi şunlardır:

a.

b.

(her boşluk 1 puan)

c. Çok hücreli canlılardaki genetik çeşitlilik Mayoz-….. evresinde …… ……. yapılmasından ileri gelir. (her boşluk 1 puan)

d. Çok hücreli bir …….. olan insan vücudu için sindirim ……. önemli bir rol üstenir. Besinlerin sindirilip vücuda dağıtılması için birkaç …… birlikte çalışır. Bunlardan bazıları olan mide ve bağırsaklar onları meydana getiren …….lardan ve onlarsa benzer yapı ve görevlere sahip …….lerden oluşurlar. (her boşluk 1 puan)

15. Çok hücreli bir canlının hücrelerinin hepsi birbirinin aynısı olmayıp görevlerine göre özel şekil ve yapılardadırlar. Örneğin insan vücudundaki hücreler sahip oldukları organellerin sayısı açısından da farklılaşabilirler veya çoğu hücre çok

küçük boyuttayken özel bazı sinir hücreleri 1 metre boyuna kadar uzayabilir. Aşağıdaki boşlukları doldurunuz: (boşluklar 0.25 puan, açıklama 0.75 puan)

a. Bir kas hücresini inceleyen Yıldız …….. organelinin fazla olduğunu görüyor, bunun sebebi şu olabilir:

b. Bitki dokularını inceleyen Kerim bitkinin yaprağında ve gövdesindeki..... organelinin köründekinden çok daha fazla sayıda olduğunu görüyor. Bu durumun sebebi şudur:

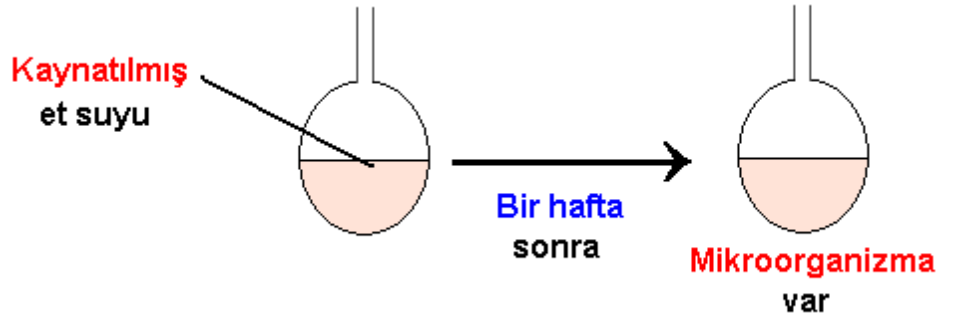
c. Ter bezi dokularını inceleyen bir bilim insanı hücrelerdeki …… organelinin fazla sayıda olduğunu görüyor. Bunun sebebini ise şöyle açıklıyor:

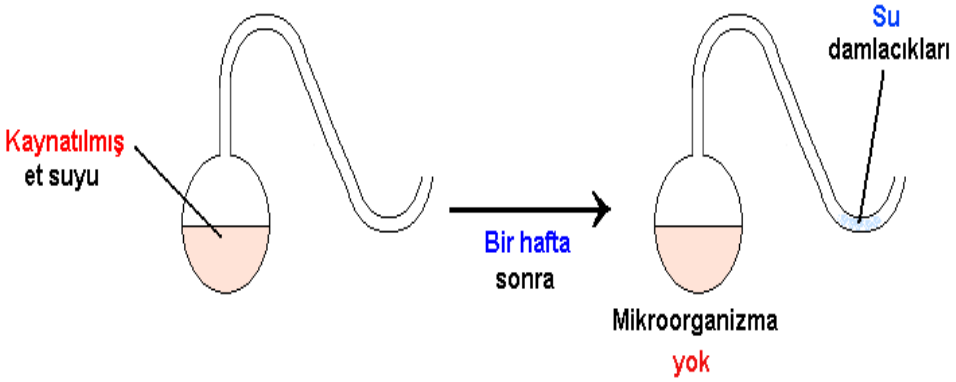
16. Bir bitki veya bir hayvanın hücrelerini çizin, yapılarını ve organellerini belirtin, organellerin görevlerini kısaca açıklayın. Organellerin isimlerini bir ok çıkarak belirtebilirsiniz. (5 puan)

17. Hücrelerle ilgili ilk çalışmaları yapan bilim insanlarından biri olan Schwann'ın hücre hakkında yazdığı kitapta ulaştığı sonuçlardan biri hücrelerin kendi kendilerine oluştuklarıydı. Ancak bu görüş başka bilim insanlarının gösterdikleri kanıtlardan dolayı bugün geçerliliğini kaybetmiştir. Her hücrenin başka bir hücreden oluştuğuna dair bugünkü anlayışımızda etkisi büyük olan Pasteur'ün deneylerinden biri ve deneyin yapıldığı dönemdeki bilimi nsanlarının görüşleri aşağıdaki gibidir:

Eski zamanlardan gelen bir düşünce canlıların kendi kendilerine yoktan var olduklarını öne sürüyordu. Yapılan deneyler havanın olmadığı durumlarda hücrelerin oluşmadığını gösterdi. Ancak bazı bilim insanları bu deneyi hücrelerin yoktan var olabilmesi için havaya ihtiyaçları olduğu şeklinde yorumladılar.

Bu düşünceyi test etmek isteyen Pasteur, bakterilerin oluşmasına müsait et suyunu kaynatarak bakterilerden arındırdıktan sonra iki farklı deney tüpüne koydu. İki tüp de hava almasına rağmen kıvrık boyunlu tüpteki et suyunda bakteri oluşumu gözlemlemeyen Pasteur, düz boyunlu tüpteki et suyunda bakteri oluştuğunu gördü. Deneyin şekli aşağıdaki gibidir:





Bu deney neden hücrelerin başka hücrelerden oluştuğunu kanıtlıyor? Sizce kıvrık boyunlu tüpün deneydeki etkisi ne olmuştur? Kıvrık boyunlu tüpte oluşan su damlacıklarında bakteri gözlemlemeyi bekler misiniz? Neden? (5 puan)

18. Fen ve edebiyat konularını çok seven Zeynep mayoz bölünmede genetik çeşitliliğin sağlanmadığı hayali bir dünyaya dair bir roman yazıyor. Bu dünyada bütün insanların genleri birbirleriyle tıpatıp aynıdır. Buna göre, aşağıdaki soruları kısaca cevaplayınız (her madde 1 puan)

a. Büyük bir grip salgını insanlığı nasıl etkilerdi?

b. Bir baba çocuğunu okuldan almak için okulun kapısının önüne gelmiştir. Okul çıkışında dışarı çıkan yüzlerce öğrenci içinden kendi çocuğunu kolayca seçebilir mi? Neden?

c. Romanın başkahramanı Mustafa sarmısağa alerjisi olduğunun farkındadır. Küçük kardeşi Aydın'ın sarmısağı ilk kez yediğinde ne olmasını beklersiniz? Neden?

d. Bu dünyadaki öğretmenler öğrencilerin çoğunun sporda çok becerikli olduklarını ancak, matematik konusunda genellikle zorlandıklarını gözlemlemektedir. Sizce bunun sebebi ne olabilir?

C. INFORMED CONSENT FORM FOR PARENTS

Veli Onay Formu

Sevgili Anne/Baba,

Bu çalışma Orta Doğu Teknik Üniversitesi Eğitim Bilimleri Bölümü'nde yüksek lisans yapan Armağan Anteplioğlu tarafından yürütülmektedir.

Bu çalışmanın amacı nedir?

Çalışmanın amacı, proje tabanlı öğrenme methodu kullanılarak araştırmacı tarafından oluşturulmuş bir eğitim programının öğrencilerin fen dersi başarısı ve fen derslerine yönelik tutumlarının üzerindeki etkisini gözlemlemektir. Proje tabanlı öğrenme öğrencilerin öğrendiklerinin bir sonucu olarak bir proje üretmesinin istendiği, öğrenciyi aktif şekilde düşünmeye, teori ile pratik arasındaki bağlantıları keşfetmeye, deneme yanılma sürecine sevk eden bir öğrenme yöntemidir. Bu çalışmada öğrencilerden Hücre ve Bölünmeler üniteleri için projeler üretmeleri istenecektir. Çalışmaya başlamadan önce ve çalışma bittikten sonra uygulanacak başarı analizleri yöntemin etkililiği değerlendirilecektir.

Çocuğunuzun katılımcı olarak ne yapmasını istiyoruz?

Çalışma başlamadan önce Bitez Gülümser Mehmet Danacı İÖO, Ortakent Kerem Aydınlar İÖO ve Turgutreis Vedat Türkmen İÖO öğrencilerine ders saatlerinde bir fen bilgisi testi verilecektir. Velisi olduğunuz öğrencinin sınıfı rastgele yapılacak atama sonucu deney grubuna atanırsa, yukarıda açıklanan yöntem ile öğrencilere 6 hafta boyunca bir eğitim verilecek ve eğitim sonunda projelerini oluşturmaları istenecektir. Kontrol grubunda olan öğrenciler ise geleneksel bir fen bilgisi kursu görecektir. Çalışmanın sonunda ve çalışma bittikten bir ay sonra tüm öğrencilerden çalışmanın başında yapılan testi tekrar yapmaları istenecektir. Sizden çocuğunuzun katılımcı olmasıyla ilgili izin istediğimiz gibi, çalışmaya başlamadan çocuğunuzdan da sözlü olarak katılımıyla ilgili rızası mutlaka alınacaktır.

Çocuğunuzdan alınan bilgiler ne amaçla ve nasıl kullanılacak?

Çocuğunuzdan alacağımız cevaplar tamamen gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir. Elde edilecek bilgiler sadece bilimsel amaçla kullanılacak, çocuğunuzun ya da sizin ismi ve kimlik bilgileriniz, hiçbir şekilde kimseyle paylaşılmayacaktır.

Çocuğunuz ya da siz çalışmayı yarıda kesmek isterseniz ne yapmalısınız?

Katılım sırasında sorulan sorulardan ya da herhangi bir uygulama ile ilgili başka bir nedenden ötürü çocuğunuz kendisini rahatsız hissettiğini belirtirse, ya da kendi belirtmese de araştırmacı çocuğun rahatsız olduğunu gözlerse, çalışmaya sorular tamamlanmadan ve derhal son verilecektir. Şayet siz çocuğunuzun rahatsız olduğunu hissederseniz, böyle bir durumda çalışmadan sorumlu kişiye çocuğunuzun çalışmadan ayrılmasını istediğinizi söylemeniz yeterli olacaktır.

Bu çalışmayla ilgili daha fazla bilgi almak isterseniz:

Çalışmaya katılımınızın sonrasında, bu çalışmayla ilgili sorularınız yazılı biçimde cevaplandırılacaktır. Çalışma hakkında daha fazla bilgi almak için Armağan Anteplioğlu ile iletişim kurabilirsiniz. Bu çalışmaya katılımınız için şimdiden teşekkür ederiz.

E-posta: armagan.anteplioglu@metu.edu.tr

Telefon: 0534 382 43 38

Yukarıdaki bilgileri okudum ve çocuğumun bu çalışmada yer almasını onaylıyorum
(Lütfen alttaki iki seçenekten birini işaretleyiniz.)

Evet onaylıyorum___ ***Hayır, onaylamıyorum___***

Annenin adı-soyadı: _____ Bugünün Tarihi:_____

Çocuğun adı soyadı ve doğum tarihi:_____

(Formu doldurup imzaladıktan sonra araştırmacıya ulaştırınız).

D. APPROVAL BY THE METU HUMAN SUBJECTS ETHICS COMMITTEE

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
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Sayı: 28620816 / 331

06 Haziran 2018

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Prof. Dr. Ali YILDIRIM

Danışmanlığını yaptığınız yüksek lisans öğrencisi Armağan ANTEPLİOĞLU'nun **"Proje Temelli Ortaokulda Hücre ve Bölünmeler Ünitesi İçin Akademik Başarı ve Tutuma Etkisi: Deneysel Bir Çalışma"** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2018-EGT-092** protokol numarası ile **08.10.2018 - 30.12.2018** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Ş. Halil TURAN
Başkan V

Prof. Dr. Ayhan SOL
Üye

Prof. Dr. Ayhan Gürbüz DEMİR
Üye

E. APPROVAL BY THE MUĞLA EDUCATIONAL DIRECTORATE

T.C.
MUĞLA VALİLİĞİ
İl Millî Eğitim Müdürlüğü

ÇANKAYA
ANKARA

ÖIDB

Sayı : 70004082-605.01-E.19321720 15.10.2018
Konu : İzin

ORTA DOĞU TEKNİK ÜNİVERSİTESİ REKTÖRLÜĞÜNE
(Öğrenci işleri Daire Başkanlığı)

İlgi :a)Valilik Makamının 12/10/2018 tarihli ve 19188915 sayılı Makam Oluru.
b)15/08/2018 tarihli ve 12423 sayılı yazınız.

Orta Doğu Teknik Üniversitesi Eğitim Bilimleri Anabilim Dalı Eğitim Programları ve Öğretim Programı yüksek lisans öğrencisi Armağan ANTEPLİOĞLU' nun İlimiz Bodrum İlçe Milli Eğitim Müdürlüğüne bağlı orta öğretim kurumlarına yönelik araştırma çalışma uygulaması talebi ile ilgili ilgi (a) Makam Oluru yazımız ekinde gönderilmektedir.

Gereğini arz ederim.

Pervin TÖRE
İl Milli Eğitim Müdürü

EKLER:
1-İlgi (a) Makam Oluru (1 sayfa)
2-Araştırma değerlendirme formu (1 sayfa)

F. TURKISH SUMMARY / TÜRKÇE ÖZET

1. GİRİŞ

Sürekli ilerleyen rekabetçi bir dünyada eğitim, gençlerin bilgi ve becerilerini geliştirerek onları geleceğe hazırlamada önemli bir rol üstlenmektedir. Teknolojik gelişmeler, küreselleşme ve iş piyasasındaki değişimler eğitilmiş işgücüne olan talebi arttırmış ve özellikle eğitim düzeyi düşük bireylerin iş bulmaları zor hale gelmiştir. Özelleşmiş iş gücüne olan artan talep, bireylerin başarılı çalışanlar olabilmeleri için ihtiyaç duydukları nitelikleri doğal olarak değiştirmektedir.

Günümüzde özelleşmiş uzmanlık ve bilginin anlamlı bir şekilde kullanılması giderek daha fazla önem kazanmaktadır. Uzmanlar üzerinde yapılan araştırmalar, onların yüksek derecede organize edilmiş, önceden öğrenilmiş, alana özgü çok geniş bir bilgi birikimini kullandıklarını göstermektedir. Bilgiyi anlamlı 'yığınlar' halinde çalışma belleğini zorlamayacak şekilde uzun süreli bellekte organize edip depolamak uzmanların bilgilerini problemleri çözmede büyük bir etkililikle kullanmalarını sağlamaktadır. Böylesi geniş ve iyi organize edilmiş bir bilgi ağı geliştirmek zaman, odaklanma, pratik ve geribildirim imkanları ile mümkün olmaktadır. Böylesi bir anlayış, derin ve anlamlı öğrenmeye, başka bir deyişle transfer edilebilir öğrenmeye işaret etmektedir ve bu tip bir öğrenme belirli bir disipline ait bilgi, beceri ve tutumların toplamının kolayca kullanılıp daha önce karşılaşılmamış görevlere uygulanabilmesine olanak vermektedir.

Ayrıca belirtilmelidir ki, ülkeler, en çok da endüstrileşmiş olanlar, özelleşmiş derin bilgiye sahip uzman insan kaynaklarına özellikle de fen ile ilgili alanlarda rekabet yeteneklerini kaybetmemek için ihtiyaç duymaktadırlar. Bu ihtiyaç Amerika'da STEM'in, yani fen, teknoloji, mühendislik ve matematik, ortaya çıkmasına sebep olmuştur. Avrupa'da ise MINT, yani matematik, bilgi teknolojileri, fen bilimleri, teknoloji, alanını ortaya çıkarmıştır. Dünyanın diğer milletlerinin de benzer kalifiye

insan kaynaklarına, sadece fen alanlarında değil tüm alanlarda, ekonomik büyümelerini geliştirebilmek ve halklarının refahını artırmak için ihtiyaçları vardır. Bireyleri gerekli yeterliliklerle donatmak ise doğal olarak eğitim sistemlerine düşmektedir.

O halde eğitim sistemleri öğrencileri yani geleceğin vatandaşları ve profesyonellerini gerekli bilgi, beceri ve tutumlarla yetiştirdiğinden nasıl emin olabilir? Uluslararası sınavlar bu amaca hizmet etmeye çabalamaktadırlar. OECD yürüttüğü PISA testlerinde "İnsanların neyi bilmeleri ve yapabilmeleri önemlidir?" sorusunun yanıtını aramaktadır ve 15 yaşındaki öğrencilere matematik, fen ve okuryazarlık alanlarında testler düzenlemektedir. PISA testi sadece bilginin hatırlanmasını ölçmemekte, aynı zamanda öğrencilerin öğrendiklerini ne kadar iyi yorumlayıp bilgilerini ne kadar iyi kullanabildiklerini de ölçmektedir. IEA tarafından düzenlenen başka bir test olan TIMSS ise 4 ve 8. sınıf öğrencilerine uygulanan ve okul bilgilerini ölçen bir sınavdır. Genel olarak PISA testinin öğrencilerin öğrendiklerini ne ölçüde kullanabildiğini, yorumlayabildiğini ve paylaşabildiğini alan bilgisine çok bağımlı kalmadan ölçen bir test olduğu söylenebilirken, TIMSS daha çok belirli müfredat bilgilerini ölçmeye odaklanmıştır.

Türkiye'nin bu sınavlardaki başarısı sınırlı kalmıştır. PISA'da ortalama skor, 2005 yılı dışında, gittikçe yükselse de hiçbir zaman ortalamanın üzerine çıkamamıştır, üstelik sınava katılan ülkeler arasındaki sıralamamız 2009'dan beri düşmektedir. TIMSS'de ise ortalama skorumuz ve dünya sıralamamız gitikçe yükselmekte ancak yine de dünya ortalamasının altında kalmaktadır.

Dahası, ulusal çaptaki merkezi sınavlarda da milli eğitimin eksiklerini göz önüne çıkarmaktadır. ÖSYM'nin düzenlediği 2016-2017 TEOG fen sınavında öğrencilerin %8'i sorulan soruların dörtte birine cevap verememişken, %34'ü soruların yarısını yanıtlayamamıştır. Matematik için bu değerler sırasıyla %12 ve %54'tür. Üstelik dağılımın negatif eğikliği sınavların kolay olduğuna işaret etmektedir.

Bu sorunları çözmek ve Türk eğitim sistemini reforme etmek amacıyla Milli Eğitim Bakanlığı (MEB) pek çok yeni düzenleme ve uygulama getirmiştir. PISA testlerine

katılmak, zorunlu eğitimin uzatılması, özellikle kızlar için okullaşma oranının yükseltilmesi için projeler, ödeneklerin artırılması, öğretmen eğitiminin iyileştirilmesi, eğitimde bilgi teknolojilerinin yaygınlaştırılması 2000'li yıllardan beri yapılan reformlar arasındadır. Eğitim programları açısından en önemli nokta 2004'te davranışçı yaklaşım, metot ve teknikleri kullanan eğitim programlarının oluşturmacı olanlarla değiştirilmesiyle yaşanmıştır. MEB yeni programın ilerici, spiral, bilgi edinilmesi için alternatif metot ve teknik kullanan, öğrencinin araştırmasını teşvik eden, çoklu değerlendirme araçları kullanan, yaşamı kaynak olarak gören, okul-aile birliğini temel alan ve öğrenciyi merkeze alan bir idari yapıyı benimseyen bir program olduğunu belirtmektedir. 2004'teki değişimden sonra fen eğitimi için birkaç farklı eğitim programı kullanılmış ve bunlardan en sonuncusu 2018'de MEB tarafından yayınlanmıştır. Bu program Bakanlığın oluşturmacı politikalarının devamı olarak düşünülebilir. Özel amaçları içinde MEB, programın 'bilimsel süreç becerilerini ve bilimsel araştırma yaklaşımını benimseyip alanda karşılanan sorunlara çözüm üretmek, günlük yaşam sorunlarına ilişkin sorumluluk alınmasını ve bu sorunları çözmede fen bilimlerine ilişkin bilgi, bilimsel süreç becerileri ve diğer yaşam becerilerinin kullanılmasını sağlamak, bilimsel bilginin bilim insanlarınca nasıl oluşturulduğunu, bu bilginin geçtiği süreçleri ve yeni araştırmalarda nasıl kullanıldığını anlamaya yardımcı olmak, sosyobilimsel konuları kullanarak muhakeme yeteneği, bilimsel düşünme alışkanlıkları ve karar verme becerileri geliştirmek' gibi oluşturmacı anlayışla uzlaşan amaçlarını ifade etmektedir. Programda ayrıca analitik ve yaratıcı düşünme, girişimcilik, iletişim, takım çalışması ve inovatif düşünme becerilerinin yanı sıra gözlemleme, hipotez kurma, modelleme, değişkenleri değiştirme, deney yapma gibi beceriler de kapsanmaktadır.

Ancak reformlara rağmen, Türkiye'nin ulusal ve uluslararası sınavlardaki durumu öncekinden çok değişmemiştir. Bunun karmaşık sebepleri olduğu kabul edilse de, sebeplerinden biri eğitim programlarının uygulanış şeklidir. Ülkemizde yapılan araştırmaların çoğu öğretmen adaylarının kendilerini oluşturmacı olarak gördüklerini göstermekte, ancak düşünceleri ve sınıflardaki uygulamaları arasında farklar olduğunu göstermektedir, uygulama geleneksel, davranışçı ve öğretmen

merkezli uygulamalara benzemektedir. Derin uzman bilgisi geliştirmek ve eğitim programlarımızı iyileştirmek için yeni öğretim metotları üzerindeki araştırmalar yararlı olabilir. Geleneksel öğretim metotlarının derin bilgiye erişmenin en uygun yolu olmadığı öne süren birtakım çalışmalar bulunmaktadır ve bu durum düşük öğrenci başarısının da bir sebebi olabilir. Bu bağlamda, proje tabanlı öğrenme bu hedefe ulaşabilmek için kullanılabilecek bir yöntem olarak kısaca tanıtılacaktır.

Yeni öğretim ve eğitim yaklaşımlarının pek çoğu anlamlı ve derin öğrenme vaadetmektedir. Bunlardan biri olarak, proje tabanlı öğrenme (PTÖ) oluşturmacılığın prensiplerinden yola çıkarak oluşturulmuş bir öğretim metotudur. PTÖ'nün temel sayıltısı öğrencilerin bizzat çalışıp düşünerek bilgilerini aktif şekilde inşa ettikleri ve konu hakkında derin bir anlayış edindikleridir. PTÖ'de öğrenciler öğrenmelerinin bir ürünü olarak özellikleri önceden belirlenmiş bir eser meydana getirirler. Başka bir tanıma göre, PTÖ öğrencilerin bireysel veya küçük bir grupla birlikte gerçek hayattan meseleler ve problemler hakkında somut çıktılar üretmeleri prensibini güden bir öğretim yaklaşımıdır. Literatürde PTÖ'nün beş anahtar özelliğine işaret edilmektedir:

1. Güdüleyici bir soruyla veya bir problemle başlarlar.

2. Öğrenciler güdüleyici soruyu disiplinin uzmanlarının kullandıklarına benzer problem çözme süreçlerine katılarak araştırırlar. Araştırdıkça disiplinin önemli fikirlerini öğrenir ve uygularlar.

3. Öğrenciler, öğretmenler ve camia mensupları güdüleyici soruya cevap bulmak için işbirliği yaparlar. Bu, uzmanların sorun çözmelerindeki kompleks sosyal durumu simüle eder.

4. Araştırma sürecindeyken öğrenciler normalde becerilerinin dışında olan aktivitelere katılabilmelerini sağlayan öğrenme teknolojileri ile desteklenirler.

5. Öğrenciler güdüleyici soruya yönelik birtakım somut ürünler yaratırlar. Bunlar paylaşılan eserlerdir ve sınıfın öğrendiklerini herkesin ulaşabileceği şekilde temsil ederler.

1.1. Araştırmanın Amacı

Bu araştırmanın amacı proje tabanlı öğretimin ve öğrenmenin 7. sınıf Fen Bilimleri dersi üzerindeki etkisini kontrol gruplu yarı deneysel desen ile araştırmaktır. Araştırma soruları aşağıdaki gibidir:

1. Deney (PTÖ) ve kontrol grupları arasında Hücreler ve Bölünmeler Son Testi ile ölçülen başarı arasında anlamlı bir fark var mı?

2. Deney (PTÖ) ve kontrol grupları arasında Hücreler ve Bölünmeler Kalıcılık Testi ile ölçülen başarı arasında anlamlı bir fark var mı?

1.2. Araştırmanın Önemi

Bu çalışmadan çıkarılacak sonuçlar ile PTÖ'nün Türkiye'nin değişen eğitimsel atmosferinde test edilmesi ve oluşturmacı etkin öğretim ortamları kurulabilmesi için öğretmen eğitimi, öğrencilerin etkili projeler vasıtasıyla öğrenebilmeleri için gerekli süreçler ve materyallerin ortaya çıkarılması, okulların ihtiyaç duyduğu altyapıların belirlenmesi gibi meselelerde bilgi sağlanması beklenmektedir. PTÖ aynı zamanda 21. yüzyıl becerileri edinimi ve çeşitli öğrenci nüfusları arasındaki ders başarısı farkının azaltılmasında da umut verici görünmektedir. Bu çalışmanın sonuçları bu konularda bilgi sağlayabilir. Ayrıca çalışmanın iki okulla ve benzer çalışmalara kıyasla görece daha büyük örneklemi, deneysel yöntemin kullanılması ve kalıcılık testinin yapılması çalışmanın özel nitelikleri arasındadır.

2. LİTERATÜR TARAMASI

Literatür taraması üç başlık altında toplanmıştır: oluşturmacılık, proje tabanlı öğrenme ve deneysel kanıtların sunulması.

2.1. Oluşturmacılık

Davranışçı öğrenme kuramı öğrenmeyi mekanik ve pasif olarak ele aldığı için eleştirilmiştir. Piaget öğrenmenin öğrenen tarafından aktif çaba gerektirdiğini ileri sürmektedir. Oluşturmacılık insanın kendi öğrenmesini deneyimlerine ve algılarını göre inşa ettiğini savunur. Yani, öğrenenler yeni uyarıcılarla karşılaştıkça yeni bilgiler inşa ederler. Başka bir deyişle, öğrenen; araştırma, sohbet etme veya aktiviteler vasıtasıyla yeni bilgiyi var olan bilgisinin üzerine aktif zihinsel çaba göstererek inşa eder. Başkalarının söylediklerinin pasif olarak kabul edilmesi veya tekrarlanmasıyla ise bilgi edinilemez. Oluşturmacılığın diğer bir ana fikri ise, eski öğrenmelerin yenileri etkilediğidir. Yeni bilgiler veya deneyimler eskilerinin ışığında görülür ve eski bilgiler yenilerin ne şekilde inşa edileceğini belirlerler. Bu da her insanın gerçeklikten kendine has bir anlam çıkarmasına olanak verir.

John Dewey etkili bir eğitimci ve psikolog olarak oluşturmacılık ekolüne büyük katkılarda bulunmuş başka bir isimdir. Çocukların anı yaşadığını ve yaparak öğrendiklerini belirten Dewey eğitimin hayata hazırlanmak olduğunu öne süren görüşe karşı eğitimin hayatın kendisi olduğunu savunur. Çocukların fiziksel, duygusal, zihinsel, sosyal, kültürel ve ruhani varlıklar olduklarını ve eğitimin hem tasarlanması hem de uygulanması sürecinde bu özelliklerinin ve birbirlerinden farklılıklarının göz önünde bulundurulması gerektiğini vurgular. Öğretmenleri bilgi kaynakları olarak görmek yerine öğrenmenin kolaylaştırıcıları olarak tanımlar.

Piaget bilişsel gelişim kuramını ortaya atarak oluşturmacılık kuramına katkıda bulunmuştur. Deneyimler sonucu oluşturulan zihinsel yapıların, başka bir deyişle zihinsel şemaların, dünyayı açıklamada insan anlayışına rehberlik ettiğini öne sürmüştür. Piaget aynı zamanda çocukların kendi bilişsel dünyalarını oluşturduklarını ve bunda şemaların yanı sıra özümleme, uyma, dengeleme gibi kavramların etkili olduğunu yazmıştır.

Vygotsky çocuğun dünyaya öğrenebilme becerisiyle geldiğini öne sürer. Öğrenme sürecinin iki seviyede olduğunu ileri sürer: ilki insanlar arasında, ikincisi ise zihinde gerçekleşir. Çocuk yeni kavramlarla tanışıp nesne hakkında daha fazla anlayış elde

ettikçe öğrenme gerçekleşir. Öğrenmenin ön koşulu olarak sosyalleşmeyi gördüğünden Vygotsky daha becerikli insanlarla etkileşimin önemini vurgular ve Yakınsak Gelişim Alanı (YGA) kavramını ortaya atar. Buna göre YGA, bulunulan gelişim seviyesi ile daha becerikli insanlarla etkileşim sonucu varılabilecek gelişim seviyesi arasındaki farktır. Böylece bilişsel gelişim diğerleri tarafından organize edilen davranışlardan, kendiliğinden organize edilen davranışlara doğru ilerler.

Oluşturmacılık ülkemizde 2004'teki eğitim programları reformuyla eğitimin kullandığı esas kuram haline gelerek davranışçılığın yerine geçmiştir. Bu değişim doğru yönde bir adım olarak karşılanmakla birlikte, değişimin çok hızlı ve kapsamlı olmasının beklenmesi sorunlar çıkmasına sebep olmuştur. Araştırmacılar öğretmen eğitimi, gerekli araç ve gereçlerin sağlanması, okul altyapısı ve eğitim programlarının dilinin netliği ve kesinliği konularında eksiklikler bulmuşlardır. Programlarda yazanlar ile okullarda gerçekleşenler arasında büyük bir fark gözlemlenmektedir.

2.2. Proje Tabanlı Öğrenme

Proje tabanlı öğrenme (PTÖ) oluşturmacılık kuramının ilham verdiği öğretim metotlarından biridir. Benzerleri gibi öğrencileri keşfetmeye, bilgilerini oluşturup paylaşmaya, gözlem yapmaya, hipotezler kurmaya, deneyler yapmaya, analizler yapıp sonuçlar çıkarmalarına ve çevrelerindeki dünyayı tartışmalarına önem verir. Ancak benzerlerinden projelere olan odağından dolayı ayrılır.

Eğitimde projelerin kullanılması yeni değildir. 16. yüzyılın sonlarından beri projeler yapılsa da PTÖ bugünkü haline farklı evrelerden geçip değişerek gelmiştir. Okullarda kullanıldığı ilk zamanlarda oldukça kuralsız olarak uygulanıyorken bugün projelerin güdüleyici sorularının, öğrencilerin yapacağı aktivitelerin ve projenin özelliklerinin titizlikle düşünülmesi ve yapılandırılması gerektiği vurgulanmaktadır.

PTÖ'ye büyük katkıları bulunmuş Krajcik ve Blumenfeld'e göre önceden tartışıldığı gibi PTÖ'nün taşıması gereken 5 temel özellik bulunmaktadır: güdüleyici soru, öğrencilerin araştırma süreci, bu süreçte daha bilgili bireylerle işbirliği, öğrenme

teknolojileriyle sürecin desteklenmesi ve çalışmanın sonunda güdüleyici soruya yönelik somut birtakım ürünler meydana getirmek.

PTÖ gerçek yaşamda karşılaşılabilecek sorulara cevap bulmaları için öğrencileri teşvik eder. Böylece öğrenciler öğrendikleri ile hayat arasında daha fazla bağ kurabilir, toplumun sorunlarına çözüm bulmada katkıda bulunabilir ve böylece daha yüksek motivasyon sahibi olabilirler. Öğrenciler yapacakları projeler konusunda özgür bırakılmışlardır. Videolar, skeçler, bilgisayar modelleri, deneyler, şarkılar, yayınlar geniş projeler yelpazesinde yapılabilecekler arasındadır.

Ardından bilgide kalıcılığın sağlanması hakkında Bilişsel Yük Teorisi (BYT) ve bazı nörobilim araştırmaları gösterilmiştir. BYT'ye göre çalışma belleğinin kısıtlı kapasitesinin olabildiğince çoğu yeni şemaların edinilmesine ve kapsamlarının artırılmasına ve uzun süreli belleğe geçirilmelerine ayrılmalıdır. Öğretim metotları çalışma belleğini kısıtlayan dışsal yükleri mümkün olduğunca azaltmaya çalışmalıdır. Nörobilim çalışmaları ise duygusal olarak uyarıcı uyaranların uzun süreli belleğe daha kolay geçirildiğini öne sürmektedir.

Son olarak Türkiye'den ve dünyadan deneysel çalışmalar gösterilmiştir. Bunlara göre PTÖ ders başarısının, derse yönelik tutumun, motivasyonun ve birtakım zihinsel becerilerin artırılmasında kullanılabilecek uygun bir metot olarak görülmektedir. Ülkemizde daha çok ders başarısı ve tutum konuları çalışılmış ve dünyanın geri kalanından gelen verilerle uygun şekilde PTÖ'nün etkililiği gözlenmiştir. Yurt dışındaki çalışmalar ise ek olarak boylamsal araştırmalar, PTÖ'nün etkililiğine sebep olan nedenlerin bulunması, öğrencilerin ne tür şeyleri öğrenmelerine PTÖ'nün daha etkin olarak kullanılabileceği, farklı sosyoekonomik gruplardan insanların PTÖ'den ne şekilde faydalandığı da araştırılmıştır.

3. YÖNTEM

Bu çalışmanın amacı proje tabanlı öğrenmenin 7. sınıf Fen Bilimleri dersindeki okul başarısına etkisini kontrol gruplu yarı deneysel desen kullanarak araştırmaktır. Çalışmada gruplar deney ve kontrol koşullarına seçkisiz olarak atanmışlardır. Ön-test olarak iki grup da Hücre ve Bölünmeler Başarı Testi'ni cevaplamıştır. Uygulama evresinde Hücre ve Bölünmeler ünitesi deneysel gruba PTÖ programıyla, kontrol grubuna ise geleneksel öğretmen merkezli programla öğretilmiştir. Son testlerde iki grup da Hücre ve Bölünmeler Başarı Testi'ni tekrar cevaplamıştır. Kalıcılık testlerinde ise gruplar üçüncü kez testi cevaplandırmışlardır.

Araştırmanın hipotezleri aşağıdaki gibidir:

$H_0$1: Deney ve kontrol gruplarının Hücre ve Bölünmeler Başarı Testi son-test puanları arasında anlamlı fark yoktur.

$H_0$2: Deney ve kontrol gruplarının Hücre ve Bölünmeler Başarı Testi kalıcılık puanları arasında anlamlı fark yoktur.

Araştırmanın evrenini Muğla'daki tüm ortaokullar oluşturmaktadır. Erişilebilir evren ise çalışmanın kapsamından ötürü Bodrum'daki okullarla sınırlandırılmıştır. Bodrum'daki 19 ortaokul arasından iki tanesi seçilmiştir. Bu kolay ulaşılabilir örnekleme metoduyla seçilmiştir. Araştırmacı okul müdürlerinden biriyle konuşmuş ve kendisini başka okullara yönlendirmesini istemiştir. Çalışma Ortakent Kerem Aydınlar Ortaokulu ve Bitez Gülümser-Mehmet Danacı Ortaokulu'nda yürütülmüştür.

Akademik başarı açısından benzer okullar seçebilmek için okuldaki tüm 7. sınıfların bir önceki dönemdeki Fen Bilimleri puanları tek yönlü ANOVA ile analiz edilmiştir. Benzer başarıya sahip sınıflar arasından uygulama döneminde Fen Bilimleri öğretmenleri aynı olan sınıflar seçilmiş ve deney ve kontrol gruplarına seçkisiz olarak atanmışlardır. Deney ve kontrol gruplarına dört sınıf atanmıştır. Okul A'da 31 öğrenci deney grubunda (16 kız, 15 erkek) ve 30 öğrenci kontrol grubunda yer

almıştır (10 kız, 20 erkek). Okul B'de ise 30 öğrenci deney grubunda (10 kız, 20 erkek) ve 30 öğrenci kontrol grubunda yer almistir (12 kız, 18 erkek).

Toplam 121 öğrenci çalışmaya katılmıştır. Katılanların yaşları 12 ile 13 arasında değişmektedir.

Araştırmacı öğretmenlerle buluşup PTÖ ve bu çalışma için tasarlanan programı konuşmuştur. PTÖ'nün temel prensipleri, haftalık planlar ve hedefler açıklanmış ve öğretmenlerle bir hafta boyunca tartışılmıştır. Kontrol grubuna verilecek eğitim de tartışılmış ve öğretmenlerden öğretmen merkezli geleneksel davranışçı yöntemleri kullanmaları istenmiştir. Araştırmacı deney grubunun derslerine gözlem yapmak için katılmış ve öğretmenlere programın ilerleyen haftalarında da geribildirim vermiştir.

Kontrol grubunda geleneksel eğitim metotlarından faydalanılmıştır. Hücre ve Bölünmeler ünitesi çoğunlukla öğretmenlerin ders anlatımları ile sunulmuştur. Öğretmenler günün konusunu tanıtmış, tahtayı önemli bilgileri yazmak veya çizmek için kullanmış, öğrenciler defterlerine geçirmişlerdir. Derslerden sonra öğretmen anlaşılmayan yerleri sormuş ve öğrencilere hem akıllı tahtada hem de ödevlerle ekstra sorular çözdürmüştür. Ders sonunda konu özetlenmiş, çözülmek üzere sorular veya bir sonraki konuya hazırlanılması ödev olarak verilmiştir.

Deney grubunda program olarak PTÖ kullanılmıştır. Öğrenciler 4 ila 6 kişi arasında değişen gruplar kurmuş ve güdüleyici soruları cevaplayacak projeler üretmişlerdir. İlk güdüleyici soru "Bir hücre modeli tasarlayabilir misiniz?" öğrencileri hücreleri araştırmaya ve modellemeye yönlendirmiştir. Öğrencilerin projelerini hazırlamaları için yaklaşık iki hafta vakitleri olmuştur. PTÖ ile derslerini nasıl işleyecekleri ve yapacakları projelerin taşıması gereken özellikler tanıtılmıştır. İlerleyen derslerde öğrenciler öğrendiklerini ve projelerinin durumunu hem derslerde konuşarak hem de kurulan internet grubuna videolar yükleyerek açıklamış hem araştırmacı ve öğretmenden hem de kendi arkadaşlarından geri bildirim almışlardır, öğretmen yanlış veya eksik bilgileri ortaya çıkarıp düzeltmeye çalışmış ve projelerin daha iyi olması için önerilerde bulunmuştur. İki haftanın sonunda projeler sınıfla paylaşılmış ve araştırmacı tarafından değerlendirilmiştir. Aynı süreç mitoz bölünmeyi

araştırmaya sevk eden “Hücreler nereden gelir?” ve mayoz bölünmeyi araştırmaya sevk eden “İnsan olmadan önce neydiniz?” sorularında da işletilmiştir. Ayrıca grupların hazırladığı projeler bir rubrik vasıtasıyla puanlandırılmıştır.

Veriler Hücre ve Bölünmeler Başarı Testi ile toplanmıştır. Başarı testi araştırmacı tarafından geliştirilmiş 18 maddelik bir testtir. Test biri doktorasını yapmakta olan 3 Fen Bilimleri öğretmeni tarafından gözden geçirilmiş ve ünitenin kazanımlarını ölçmeye uygun olduğu belirtilmiştir. Rubrik ise projeleri dokuz seviyede 1 ile 4 puan arasında değerlendirmek için kullanılmıştır.

Verilerin toplanması 2018-2019 Sonbahar Dönemi’nin Ekim ayından Aralık ayına kadar sürmüştür. Başarı testleri araştırmacı tarafından bir ders saati içerisinde sınıflara uygulanmıştır.

Veri analizinde SPSS 23 ve Excel programları kullanılmıştır. Başarı testlerinin analizinde iki okulun ayrı olarak ön-test, son-test ve kalıcılık testi puanlarını karşılaştırmak için t-testi kullanılmıştır. Ayrıca erişi puanları da hesaplanmıştır. Son-test erişi puanı yeni bir değişken olarak son-test puanlarından ön-test puanlarının çıkarılmasıyla yaratılmıştır. Gruplar bu puanlara göre yeniden karşılaştırılmıştır. Son olarak son-test ile kalıcılık testleri arasındaki puan farkından kalıcılık erişi puanı isimli yeni bir değişken yaratılmıştır. Gruplar bu değişkene göre de karşılaştırılmışlardır.

Uygulamadan önce gerekli etik ve bürokratik izinler ODTÜ İnsan Araştırmaları Etik Kurulu ve Muğla İl Milli Eğitim Müdürlüğü’nden alınmıştır. Aydınlatılmış onam formları katılımcıların ailelerine dağıtılmış ve imzalı olarak toplanmıştır.

Bu çalışmannın iç geçerliliğini yönelik tehditlerden en önemlisi sınıflar arasındaki başarı seviyelerinin aynı olmamasıdır. 2017-2018 Bahar Dönemi’ndeki Fen Bilimleri puanlarına göre eşit sınıflar seçilmiş ancak çalışma başladıktan sonra yapılan ön-testler gruplar arasında anlamlı farklılık olduğunu ortaya koymuştur. Okul A’da kontrol grubu, Okul B’de ise deney grubu daha iyi sonuçlar almıştır. Çalışmanın devamlı yapısından ötürü katılımcı kaybı da önemli bir tehdittir. Çalışmaya 121 öğrenci ile başlanmıştır. 1 öğrenci taşınmış, 5’i ön-testi, 5’i post-testi

43'ü ise kalıcılık testini kaçırmıştır. Test etkisi başarı testinin üç kez uygulanmasından ötürü bir tehdit olarak görülebilir. Diğer tehditlerin göz ardı edilebilir oldukları düşünülmüştür.

4. BULGULAR

Uygulama öncesinde gruplar arasında fark olup olmadığının bulunması için ön-test skorları arasında t-testi yapılmıştır. Buna göre Okul A'da kontrol grubu, Okul B'de ise deney grubu anlamlı olarak daha yüksek puanlar almıştır.

İlk araştırma sorusunu cevaplandırmak için son-test verisi t-test ile analiz edilmiştir. Buna göre Okul A'da kontrol grubu deney grubundan anlamlı şekilde daha yüksek puan almıştır. Okul B'de ise tam tersi şekilde deney grubu anlamlı şekilde daha yüksek puan almıştır. Ardından son-test erişi puanları analiz edilmiştir. Okul A'da deney grubu kontrol grubuna kıyasla daha yüksek erişi puanları kazansa da aradaki farkın anlamlı olmadığı bulunmuştur, Okul B'de ise deney grubunun kontrol grubundan anlamlı derecede daha yüksek erişi puanı kazandığı saptanmıştır.

İkinci araştırma sorusunu cevaplandırmak için kalıcılık skorları değerlendirilmiştir. Okul A'da kontrol grubu, Okul B'de ise deney grubu daha yüksek puan almış ancak sadece Okul B'deki deney grubu ile kontrol grubunun arasındaki farkın anlamlı olduğu tespit edilmiştir. Bunu kalıcılık erişi puanlarının analizi takip etmiştir. Analizlere göre Okul A'da kontrol grubu deney grubundan daha yüksek puan alsa da aradaki fark anlamsızdır. Okul B'de ise deney grubu anlamlı olarak daha yüksek erişi puanı kazanmışlardır.

5. SONUÇLAR VE ÖNERİLER

Bu bölümün ilk kısmında çalışma özetlenmiş, sonuçlar tartışılmış, ve son olarak uygulama ve gelecekteki araştırmalar için çalışmanın çıkarımları belirtilmiştir. Özet kısmına bu raporda yer verilmeyecektir.

Bulgular programın başarılı olduğu Okul B'de deney grubu her testte kontrol grubunun anlamlı olarak önüne geçtiğini, programın başarılı olmadığı Okul A'da ise kontrol grubunun sadece son-test puanlarında daha başarılı oldukları göstermektedir. Buradan yola çıkılarak PTÖ'nün geleneksel eğitime kıyasla kısmen daha başarılı olduğu söylenebilir. Çalışmanın, bu açıdan daha önce yapılan araştırmaların sonuçları ile uyumlu olduğu görülmektedir. Ancak sonuçlar PTÖ'nün başarılı olması için bazı önkoşulların sağlanması gerektiğini de göstermektedir.

Öğretmen eğitimi en önemli önkoşul olarak görülmektedir. PTÖ öğretmen merkezli yaklaşımdan farklı olarak öğrencilerin aktif katılımını gerektirdiğinden, onlara etkili şekilde liderlik etme becerisinin hem teorik hem pratik yönlerinin öğrenilmesi hem hizmet içi öğretmenler hem de öğretmen adayları için kritik öneme sahiptir.

Okul imkanları ve bilgiye ulaşım da PTÖ'nün başarılı olabilmesi için önemli görülmektedir. Öğrencilerin internet, önceden hazırlanmış kaynaklar veya laboratuvar vasıtasıyla bilgiye erişimleri arttıkça PTÖ'nün de daha etkin sonuçlar üreteceği düşünülmektedir. Ayrıca sınıf mevcutları öğretmen desteği ve sınıf yönetimi açısından önemli görünmektedir. Öğretmenin sürekli olarak küçük gruplarla ilgilenmesini gerektiren PTÖ gibi metodun 20'den az öğrenciyle daha verimli sonuçlar vereceği düşünülmektedir.

Okul B'deki bulgular da ilgi çekicidir. Genel olarak proje puanları Okul A'dakilere kıyasla daha düşük olmasına rağmen Okul B'deki deney grubu her testte kontrol grubundan anlamlı olarak daha yüksek puanlar almıştır. Literatürde düşük başarılı öğrencilerin PTÖ'den daha fazla faydalandıklarına dair bulgular mevcuttur. Bu çalışma öğrencilerin başarı düzeylerini veya dezavantajlı grupları karşılaştırma

amacı gütmediğinden sonuçlar fazla güvenilir olmasa da, çalışma bu açıdan literatürle bağdaşır sonuçlar içermektedir. Bu konuda daha fazla araştırma gereklidir.

Uygulama ve gelecekteki araştırmalar için çıkarımlar da yapılmıştır. Uygulamaya dair çıkarımlarda PTÖ'nün daha aktif olarak kullanılmasının yararlı olabileceği ancak yapılandırılmış derslerin gerekli olduğu, bu konu hakkındaki öğretmen eğitiminin önemi ve okul imkanları ve materyallerinin programlarla uyumlu hale getirilmesi vardır. Gelecekteki araştırmalara dair önerilerde ise boylamsal çalışmaların gerekli olduğunun belirtilmesinin yanı sıra; PTÖ'nün çeşitli becerilerde gelişimi sağlamaya yardımcı olup olmadığının, PTÖ'nün öğrencilere nelerin öğretilmesinde daha yararlı olduğunun, avantajlı/dezavantajlı öğrencilerin arasındaki başarı farkının kapatılması için PTÖ'nün nasıl kullanılacağının, öğretmen eğitiminin PTÖ deneyimine etkisinin ve PTÖ'nün farklı ölçme yöntemleriyle değerlendirilmesinin araştırılmasının yararlı olabileceği belirtilmiştir.

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