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THE EFFECT OF PROJECT-BASED LEARNING ON STUDENTS' ACHIEVEMENT IN MATHEMATICS

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Abstract

The aim of this research was to investigate the effect of project-based learning (PBL) on second-course education mathematics students' achievement. The study was carried out 5 weeks with 37 students in a principle of geometry course at Suleyman Demirel University in Kazakhstan. The final results were obtained to measure students' academic achievement as pre-test and post-test were obtained. Data were analyzed using a t-test. The results of the achievement test indicated PBL has a significant positive effect on students' achievement in the principle of geometry course.

Keywords: Mathematics achievement; Project-based learning; attitude towards PBL

The primary demand in today's market is the search for people who are ready to compete in a world based on technology. In order to have a successful career in the current and future economy, they must have a good knowledge of mathematics. Mathematics is taught at all stages of children's learning, but repeatedly students face difficulties with the content, which can lead to their loss of interest and avoidance of learning mathematics. These factors can lead to a lack of math ability, which can lead to future struggles in both college and the workforce.

Young math students are often not motivated for a mixture of different reasons. One of them may be the repetitive and ordinary type of teacher-oriented teaching approach that is valid in high school mathematics lessons. Project-based learning, which is a project-based learning method depending on real-world problems and group collaboration, can be the solution of the usual and daily classical teaching methods that many students are familiar with the concept. (Beres, 2011). Banda, Matuszny, and Therrien (2009) stated: "Boosting student motivation is a complicated and continuing procedure, specifically for those students who repeatedly failed mathematics in the past."

Mathematics teachers in high school spend an enormous amount of time engaging with pupils who have different opinions about the significance and usefulness of mathematics. While some students have the unfavorable mathematical experience, other students do not yet know the content of the subject. This negative experience and being unfamiliar with the content makes it harder for students to learn new materials. These students often feel depressed and "withdrawn," making teaching and learning a constant challenge. Therefore, we aim to resolve how teaching methods change students' desire and understanding of mathematics.

Project-based learning is a contemporary learning method in which participants apply and complete original projects while working in small shared groups. As an example, you can think of Project-Based Learning (PBL) as a student-guided learning method in which students can research topics that are of interest and also achieve academic targets. Also, PBL can be interdisciplinary or contain one specific area. Moreover, PBL has the ability to intrigue scholars

and allow them to work on "contextual issues that can help them combine what they grasp at school with their struggle outside of school" (Jurow, 2005).

According to Bell (2010), "Project-Based Learning is a critical program for encouraging students to be self-sufficient thinkers. Teenagers solve their real problems by developing their questions, designing their education, and establishing their research and applying many learning strategies. As reported by Larmer and Mergendoller, there are seven key factors for project-based learning. Prosperous project training should draw students' interests first and then with compelling problems should keep the attention of the participant. Giving students the right to vote on the project and allowing them to make their own choices improves individual studying and learning, and also encourages students so that they can ask their propulsive questions. Students working in groups gain valuable skills that are necessary for the 21st century, such as including teamwork, communication with others, and critical and creative thinking. The aspect of the teacher as a facilitator is to provide feedback and approve students to evaluate using rules of assessment. The final component of fruitful PBL is the "openly given fruit" (Larmer and Mergendoller, 2010).

Jurow (2005) referred to several researchers who stated that "the project-based curriculum can appeal to students and equip students with the opportunity to study contextual topics that can help them connect what their experiences in and out of school (Brown, Collins, and Duguid, 1989; Boaler, 1998; Blumenfeld et al., 1991;). "

In similar research, Ocak and Uluyol (2010) scrutinized how a PBL setting could affect factors of underlying motivation, exactly interest, intellectual interaction, and academic competence, In line with the results of the research, Ocak and Uluyol discovered that PBL undoubtedly changed participation percentage and involvement in the class. In PBL, students felt a reasonable burden to complete their homework assignments, and it also increased contact and engagement among group members.

Meyer (1997) and his coauthors advocated instructors need to have an inherent shield for their students; educators should accentuate that advancement is as beneficial as an end product

and allow it to examine confusions with companions. Team Collaboration can help students overcome problems rather than avoid problems. According to Meyer (1997) and his coauthors, "When projects are intellectually complicated, there is a higher chance to help students to comprehend because they need to present information in different ways, reveal and figure out real-world problems, and use that information to produce. Projects also have the potential to push students beyond their limits and overcome their fear and break out their comfort zone to search for alternative routes (Meyer, Spencer, and Turner, 1997).

One other Doppelt study (2003) examined the impact of project-based education on people where PBL is ineffective.

The results showed PBL increases scholar impetus and self-esteem. Results after the three-year program, 69% of those who were once "late learners" were able to achieve excellent results in order to qualify for higher education in Israel.

Active student engagement based on curriculum results is enveloped in complex concepts (Blumenfeld & Krajcik, 1994) using PBL abilities. The mandatory target for PBL is that students "understand" rather than "do" to "do" (Barron et al., 1998). For this to happen, Barron et al. (1998) proposed four principles to understand: "1) relevant learning objectives, 2) forests that support student and teacher education, 3) frequent self-assessment and formative review opportunities, and 4) social organizations that encourage participation and create a sense of will" (p.273). These four principles contribute to the deepest level of cognitive understanding.

By creating personally important works, students present what they have mastered (Harel & Papert, 1991, cited by Grant M., 2002). Besides, students tend to have more self-determination on what they are learning, maintain the desire and motivate themselves to take more obligation for their work (Tassinari, 1996; Wolk, 1994; Worthy, 2000). With greater freedom, students "architecture their programs according to their interests and capabilities" (Moursund, 1998). In this way, project-based learning and building creation enable students to express diversity, such as skills, interests, capacities, and learning approaches.

One can immediately notice average to the tremendous positive impact of PBL on student performance compared to traditional education. In addition, the average magnitude of the impact was affected by the subject, school location, working hours, and IT support, but not by the level of education and the size of the small group.

The Implementation of PBL

Project-based learning requires a lot of preparation and planning. It starts with an idea and an important question. If someone is creating an important question to start a project and activities, they need to pay attention to many content standards. Based on these standards, create a plan that brings together as many subjects as possible in the project.

Nizwardi described and established the seven stages of the PBL model. This model was approved by trained experience with the Aiken coefficient 0,796, and this model is a decent, dependable model that allows one to implement this in the professional learning process.

It consists of seven stages:

1) formulation of predicted learning outcomes,
2) comprehend the theory of educational material,
3) skill improving and training,
4) constructing the topic of the project,
5) preparing a project outline,
6) fulfilling the duty of the project, and
7) delivery of the project report.

According to Nizwardi J.2017, the application of these seven stages was practical and very efficient and effective in enhancing student's productive capability.

Project-based learning in Math Classes

The use of PBL in mathematical education is believed to be appropriate (Savery, 2006) because it encourages students to participate in the learning process actively. PBL has the potential to facilitate mathematics work. Participation in education is an essential factor in increasing efficiency. When students work on mathematical projects and make them relevant to

their livees, they understand mathematical concepts and increase their effectiveness. Learning mathematics is no longer scary, thanks to collaborative learning, finding solutions to real problems, and discussing discoveries that are essential aspects of PBL (Uyangor, 2012). The exact nature of the projects allows students to learn their learning through reesearch, collaboration, and research.

Purpose of the Study

The purpose of the study is to investigate the impact of project-based learning in second-course mathematics education in the principles of geometry class.

Research Question

1. Does project-based learning have any effect on the principles of geometry?

Procedure

If we consider project-based learning in general, it can be divided into the following stages: first, provides information and research on the results of teacher-student interaction and the relevance of research materials related to the real world (industrial and project tasks from real needs). Then try to understand the concept of educational material to give students an idea of knowledge. The role of the teacher is to guide students to study the modules and discuss them in class. Students should be actively involved in discussions about the material being read. Before creating the theme of the project, teachers and students discuss and identify specific issues. After that, it is very important to make a project proposal. At this stage, the project tasks are made in the following stages: 1. Problems and solutions 2.Structure 3.Estimated Production. Finally, completing the project tasks, the student presents the work process and the results of the project tasks.

Instrument

MAT: In order to measure students' academic achievement in geometry, a mathematics achievement test (MAT) consisting of 48 items was developed. The test was administered to 28 third course students as a pilot study. The pilot application was done on third-course students because they had learned the geometry unit earlier. Item difficulty, item discrimination, point biserial correlation, and KR20 analysis was performed on the data collected from the pilot group.

Table 1

Item Statistics for Pilot Study

Item	p	D	pbc	KR20	Item	p	D	pbc	KR20
1	0.54	0.07	0.72	0.855	**25**	0.08	0.27	0.27	0.864
2	0.29	0.24	0.55	0.860	**26**	0.33	0.38	0.29	0.864
3	0.79	0.17	0.53	0.860	**27**	0.38	0.09	0.13	0.868
4	0.96	0.15	0.04	0.866	**28**	0.21	-0.17	0.31	0.864
5	0.25	-0.04	0.26	0.865	**29**	0.21	-0.32	0.23	0.865
6	0.13	-0.02	0.25	0.864	**30**	0.13	-0.02	0.22	0.865
7	0.75	-0.11	0.44	0.861	**31**	0.08	0.13	0.33	0.863
8	0.75	-0.11	0.58	0.866	**32**	0.13	-0.16	-0.01	0.868
9	0.08	-0.15	0.01	0.867	**33**	0.25	0.25	0.52	0.860
10	0.38	-0.34	0.16	0.867	**34**	0.38	0.09	0.70	0.856
11	0.71	0.47	0.30	0.864	**35**	0.58	0.06	0.58	0.858
12	0.04	-0.01	-.10	0.867	**36**	0.46	0.08	0.70	0.855
13	0.46	-0.35	0.38	0.863	**37**	0.25	-0.04	0.38	0.862
14	0.58	0.06	0.37	0.863	**38**	0.17	0.12	0.33	0.863
15	0.29	-0.04	0.41	0.862	**39**	0.13	0.13	0.49	0.861
16	0.29	0.10	0.24	0.865	**40**	0.42	0.23	0.24	0.866
17	0.29	0.39	0.29	0.864	**41**	0.21	0.11	0.22	0.865

18	0.50	0.36	0.35	0.863	**42**	0.13	-0.02	-0.10	0.870
19	0.25	0.11	0.72	0.856	**43**	0.17	-0.17	0.13	0.866
20	0.50	-0.07	0.62	0.857	**44**	0.42	-0.06	0.69	0.856
21	0.67	0.19	0.35	0.866	**45**	0.21	-0.17	0.42	0.862
22	0.42	0.37	0.49	0.860	**46**	0.29	-0.33	0.30	0.864
23	0.33	0.52	0.40	0.862	**47**	0.25	0.25	0.70	0.856
24	0.33	0.38	0.40	0.862	**48**	0.21	0.26	0.15	0.866

*p: Item difficulty, D: Discrimination index, pbc: Point bi-serial correlation, KR20: KR20 if item deleted

When analysis was finally concluded, 24 items were removed out of the original 48 due to statistical inappropriacy (See Table 1). The items which in one way or another had figures that were unacceptable for the given statistical methods which are item difficulty, item discrimination, point bi-serial correlation, and KR20 in case of deletion, were eliminated. The left out items are shown in bold and statistical inappropriacy is shown in grey color (Table 1).

Table 1 clearly elaborates that the items have fluctuating difficulty levels hence the use of KR20 in determining internal consistency reliabilities. After the analysis, we determined that there was a coefficient of .866. KR20 is a very reliable statistic and it can be seen through its similarities with other analysis methods. Items with statistical redundancies have a lower reliability, therefore, after eliminating them, the new analysis we did using KR20 showed a coefficient of .862. Finally, MAT's final version, an efficient and valid test, was used to collect data in the main study.

Methodology

The participants in this study were 37 students (26 girls and 11 boys) aged 19-22 years in the education mathematics course.

Results

Findings Regarding the achievement test

Table 2: Result of pre-test, post-test of the experimental group

	N	Mean	sd
pre-test	20	10.6	2.177154
post-test	20	21.85	2.850877

As seen in Table 2, the results of the post-test showed a dramatic increase according to the pre-test.

Table 3: Result of pre-test, post-test of the control group

	N	Mean	sd
pre-test	17	10	2.275186
post-test	17	16.94118	2.754047

The result of table3 showed a raise but not as much as the experimental group.

Table 4: Result of post-test of experimental and control groups

	N	Mean	sd
pre-test	20	21.85	2.850877
post-test	17	16.94118	2.754047

According to Table 4, there is a difference between the averages of the post-test results of the experiment and the control group. So project-based learning has made a difference in favor of the experimental group. However, whether this difference is significant is seen in Table 5.

Table 5. Independent sample t-test results

t	df	p	Mean Difference
5.17	34	1.04E-05	4.9

The t-test results indicate that peer instruction has an effect on students' achievement.

Discussions

The present study examined the effect of project-based learning on the second-course education math students in a principle of geometry course at Suleyman Demirel University with 37 students. An achievement test consisting of 25 questions was prepared by the author to measure the success of the students. The project-based learning was applied in teaching course concepts to the treatment group while the comparison group was exposed to the traditional instruction method approach. According to statistical analyses, there were statistically significant differences between both groups' average mean post-test.

Conclusion

Project-based learning (PBL) is an innovative approach based on the planning and development of ideas and imagination. PBL emphasizes the stages of students, individually or as a group, such as planning the individual learning process, conducting research, working together, taking responsibility, obtaining information, organizing information (Erdem&Akkoyunlu, 2002). Gardner (1985) argues that students with a positive outlook are more academically successful than students with a negative outlook.

Based on the analysis of the results of the study, it was concluded that the model of teaching based on the project-based learning model of students in the course of geometry at Suleyman Demirel University in Kazakhstan helped effectively. The characteristics of mathematical communication skills and curiosity of students have increased. A project-based learning model can be used as an alternative learning model for

studentstobeappliedintheclassroominorder to improve students' mathematical communication skills. The participants think that PBL is an effective teaching method for learning and doing research in their careers.

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