British Journal of Education

Vol.6, No.4, pp.70-83, April 2018

Published by European Centre for Research Training and Development UK (www.eajournals.org)

EFFECTIVENESS OF PROJECT-BASED LEARNING STRATEGY ON THE ACHIEVEMENT AND MATHEMATICAL WRITING OF PREPARATORY YEAR STUDENTS AT NAJRAN UNIVERSITY

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ABSTRACT: *The problem of low academic achievement in mathematics at university is one of the most important educational and psychological issues that may lead to students' suffering, failure, and poor personal and social adjustment. The present study aimed to address the impact of project-based strategy on the promotion of the academic achievement and mathematical writing of the preparatory year students at Najran University. The present study was applied to fifty students enrolled in the "Introduction to Mathematics" course in the second semester of the academic year 2016/2017. Quasi-experimental approach was used. Results of data analysis indicated that there were significant differences between the means scores of participants in the control and experimental groups in the academic achievement and mathematical writing due to the use of project-based strategy that was used during the course period.*

KEYWORDS: Project-Based Learning, Strategy, Achievement, Mathematical Writing, Preparatory Year Students, Najran University

INTRODUCTION

At present, educational philosophies tend to use new teaching strategies that are based on the learner's effectiveness and self-activity.The philosophy on which lecturing,as a strategy, was based has been replaced by new philosophies. Old teaching philosophy regarded the teacher as the center of all educational activities, work and thinking. Student's mind was seen as an empty container, which the teacher had to fill it in with the new information and knowledge. However, some of modern philosophies look at the learner himself as the center of activity. New information can not be meaningful for the learner unless he exerts self-effort to learn them and tries to gain real kinds of experience as they expand his intellect and help him be more capable in solving the problems he encounters. Nevertheless, reality of learning the content of the teaching courses does not reflect such trend. Many courses, especially mathematics, focus on lecturing and indoctrination strategies, which aim to fill students' minds with information. No attention is paid to understanding and realization of this new information. Therefore, it is time to change the concept of teaching from rote learning and memorization to understanding and comprehension. It is time to change the learner from being passive who only receives information from the teacher to be active when participating in the process of learning, (Al Hawwas, 2006).

Zaitoun (2003) argues that theoretical ideas of teaching should be transferred into reality inside school life. The learner should share the teacher the acquisition of much experience and information as possible as he can. The need for real education that inspires good behavior in young people and equips them with the experience necessary for contemporary lifehas been urgent. Hence, modern trends have started to focus on a new and renewed concept of the role of the teacher, in general and the role of mathematics teacher, in particular that organizes the

Print ISSN: 2054-6351, Online ISSN: 2054-636X

curriculum and makes it clearer viasurvey and discovery far away from indoctrination or direct teaching. The linkage between mathematics and its applications in life is the cornerstone of scientific and technical progress because these applications present the idea of human aspect of mathematics. These applications should be essential in the teaching of mathematics to make its learning meaningful and to highly motivate students to learn it, to develop their attitudes towards it and to encourage them to face their life problems because it is not far away from learners' real lives. Learning of mathematics will be useless and rote and retention-based that ends with exams unless it is related to all forms of the individual's life, (The Guide of International Educators, 2008).

Strategies of active learning enable students to connect mathematics to life, contribute to their learning and create an interactive learning environment that increases student confidence. Methods and strategies of teaching mathematics play a significant role in raising students' achievement and developing their ability in their mathematical writing. On the other hand, Students' preoccupation with learning is a daily challenge for all teachers whether beginners orexperienced. It is a continuous active process that depends on the classroom situation the teacher usually encounters. It requires knowledge and understanding of the students in addition toknowledge of the most appropriate and effective teaching strategies for these students. For example, students can use their interests and experience to connect new knowledge with what they already know.Once they can do so, new knowledge will mean something new for them and they will understand that it is worth working on it. When the task has a realistic relation withlife, students will understand the importance of its completion,(Abu Zeina 2010).The project-based learning strategy is one of thoseactiveand learner-centered strategies. It began to emerge at the beginning of thiscentury. Nevertheless, its various uses were limited to the practical issues and manual works until the time when Kilpatrick introduced them to schools as a strategy for teaching.In this strategy, Kilpatrick referred to and stressed the Dewey's ideas related to the use of a practical and applicable strategy that organizes curricula into purposeful projects related to students' lives and stemmed from their needs and desires.(Gibson,2008). Furthermore, project-based learning strategy has many positive aspects. It, for exampledevelops the spirit of teamwork, cooperation in collective projects and free competition in the individual projects. It encouragesindividualized learning and the distinction of individual differences among learners as the learner is the center of the educational process. It also prepares learners for life outside the schoolbecause it translates what theylearn theoretically into concrete reality. It also encourages the learner to work and produce. Therefore, learning will not achieve its purposes and objectives unless students connect theoretical aspects with practical ones, which is the best kind of learning. Besides, project-based strategydevelops students self-confidence and love of work and encourages them to be creative, innovative and responsible, (Sternberg & Williams, 2004).The project, in itself is a uniqueand learner-centered educational method where the teacher's role is limited to supervision, guidance and help when needed. Project- based strategy is one of the most appropriate teaching strategies because students perform self-activities under the supervision of their teacher. Furthermore, it is one good method for the organization of the school curriculum, (Nabhan, 2008).

Statement of the problem

The problem of learners' low academic achievement at university especially in mathematics is one of the most important educational and psychological issues that concern, if not worry, educators and parents. It is a problem that has a serious impact on studentsand may lead to

Print ISSN: 2054-6351, Online ISSN: 2054-636X

suffering, failure, and poor personal and social adjustment. It causes a loss in the educational system inputs when students leave university as a result of their sense of failure. In addition, students, at public education complain from their weakness in thewriting skill. Their perspectives regarding this weaknessvary, but whatever these perspectives are, it is believed that teachers' lack of awareness of the written work and its proper use are of the main reasons that can cause this weakness, (Mar'i & Al-Hila, 2002).

Findings of previous studies, in addition to the researcher's experience in this field, have indicateda general weakness in students' mathematical ability. They have also shown that the academic achievement of university students in all branches of mathematics is low. Hence, there is an urgent need todevelop and versify the teaching methods and strategies to cope with the changing needs of students and to go along with the changes in the general guidelines of mathematics curriculum, (Al Anzi, 2007). Besides,mathematics teaching should be related to the natural context of life so that learners can acquire skills, knowledge and values presented in the form of real tasks related to their lives, which enhance their understanding of mathematical concepts, make them more effective in discovering mathematics and contribute to enhancing their ability to solve their problems.

In conclusion, the present study tries to improve the academic achievement and mathematical writing of the preparatory year students at Najran University via the use of the project-based learning strategy.

Questions of the study

The present study aims to answer these questions:

1. Is there any statistical difference in the academic achievement in mathematics of the preparatory year students at Najran University due to the project-based learning strategy?
2. Is there any statistical difference in the mathematical writing skill of the students at the preparatory year at Najran University due to the project-based learning strategy?

Importance of the study

The present study is in line with the recent trends in the teaching of mathematics and the directions of the educational development, which seek to develop the learner's role in the educational process so that he can build his own knowledge regarding the constructive approach of learning. It is based on the recommendations of the National Council of the Teachers of Mathematics (NCTM) to activate the student's role so that he can participate effectively in the educational process. In brief, the present study is important because it can:

1. shed light on the effect of project-based learning strategy in the academic achievement of students at Saudi universities specially the students at the preparatory years,
2. help those people who are in charge of developing curricula to better improve the philosophy of the aims of the educational curricula being considered inside mathematics curricula for university students,
3. help teachers in the process of teaching mathematics at university and consequently contribute to the achievement of the specific aims of mathematics courses.

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Operational definitions

- **Project-based learning strategy:** It is a strategy of teaching that organizes learning via projects in a practical and research way. It guides the learner towards field work under the supervision of his teacher. Projects are those compound tasks based on a problem that challenges the learner's thinking where he practices research skills, problem solving, survey, writing, oral presentations, dialogue and reflection. The teacher, through the project, hopes to enhance the learner's achievement and ability in mathematical writing. In brief, the project is operationally defined as the teaching plans that the researcher of the present study has developed and taught students accordingly.

- **Traditional teaching strategy:** It is a teaching strategy based mainly on the teacher's effort to communicate information and concepts to the learner through indoctrination by the use of chalk and blackboard. In such strategy, the teacher's role is great in comparison with the teacher' s role in the project-based learning strategy.

- **Academic achievement in mathematics:** It is the outcome of what the student has learned. In the present study, it is operationally defined as the degree or mark which the student obtains on a test for mathematical achievement designed and prepared for study purposes.

Limitations of the study

Validity, interpretation and generalization of the results of the present study are limited to the fact that:

1. Mathematics content referred to in the present study is the content of the determined mathematics course for the students at the preparatory year at Najran University.

2. The participants in the present study are a purposeful sample of students enrolled in a course called "An Introduction to Mathematics" at the second semester of the academic year 2017/2018.

THEORETICAL FRAMEWORK AND PREVIOUS STUDIES

Theoretical framework

Mathematical writing

Writing is one communication skill in mathematics, which representsthelearner'sability to use terms, symbols, and structures to express and understand mathematical ideas and relationships.It can be expressed as "the meaning through which teachers and students can participate together in learning, understanding and practice processes". Students can express their thinking and solutions to mathematical issues in a clear, comprehensive and adequate way that others can understand and judge. On the other hand, mathematical communication is one of the most important standards for learning mathematics nowadays. Much of the educational literature about mathematics teaching has asserted the need for students to learn mathematical communication skills at all levels. Besides, the mathematical communication is one of the basic

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criteria addressed in the document of the principles and standards of school mathematicspresented by the National Council of Teachers of Mathematics (NCTM).Such a document emphasizes the need for written and verbal communication in the classroom where students organize, support, transfer, and share their ideas with their peers. To do so, they have touse the correct mathematical languageas well as using their analysis and evaluation of their peers' ideas to improve their understanding, (NCTM, 2000).Mathematical writing on the other part,is one of mathematical communication dimensions whose importance has been emphasized by the national standards. For instance, NCTM (2000) believes that students should be able to organize their ideas at their early study stages. They start writing words and sentences that gradually become clearer and longer. At the end of their high school, they become able to write mathematical ideas and proofs using accurate mathematical language.

The process of mathematics material writingshould follow a special strategy that can help students think and analyze the mathematical problem using thewriting strategy. Writing is also an important skill for students in terms of being a tool or means for explaining and expressing views for others. The use of the mathematical interaction enhances students' knowledge of the mathematical content. It gives the teacher the opportunity to test students' understanding of this content and how they develop their mathematical ability. It also helps teachers to identify what exactly students understand and how they solve problems. It also improves students' attitudes towards mathematics through their vision of mathematics, how it works in real life and how it can be used, (Al Amri, 1996). Written expression is important in the educational process because it is a strategy for a mutual dialogue among teachers and students. It helps students to discover, explain and expand their mathematical thinking. It also helps the teacher to test his students through their writings and to take correct decisions in teaching. In conclusion, written expression is a communication skill between the teacher and his students to understand classroom contexts, (Williams, 2000).

Types of mathematical writing

There are various classifications of the mathematical writing among which are:

A. **Journal writing:** Through this type of writing, the teacher encourages his students to write essays about mathematics and remarkable scientists in this field. Students can write about the concepts and ideas that their teacher has presented and about their understanding of these concepts and ideas. Journal writing is one of the most effective styles in helping students understand mathematics because it allows them to express themselves using their own language. It is a special means for learning and evaluating concepts of mathematics, (Jurdak & Abu Zein,1999).

B. **Free writing:** Free writing allows students to practice tasks, which are not constrained by a specific topic. What a student write might not definitely meet his teacher's view. He just writes about what he feels. However, activities of free writing provide tasks that look for students' knowledge of mathematics, (Elliott,1996).

C. **Memo writing:** While writing memos, students copywhat is written on the blackboard, or what is dictated by the teacher.Studentscan write memos despite their levels in the classroom. To make students benefit more,theycan beaccustomed to re-read and criticize what they have written. The teacher himself is the students' modelin the process of writing, organization and coordination, (Petter, 1996).

Print ISSN: 2054-6351, Online ISSN: 2054-636X

D. **Diary writing:** Through diary writing, studentspracticewriting expressionsabout the symbols, concepts and generalizations that theyhave learnt by short sentences. Diary writingcan develop the skill of thinking and understanding mathematical concepts.

E. **Reflective writing:** By reflective writing**,** Students can express their ideas and feelings towards a certain topic. Writing, in this case, is directed towards self not towards certain audience. It is a type of writing that explains and clarifies the steps of problem solving. There is a relationship between expository writing and solutions of mathematical problems. Furthermore, the use of this kind of writing in learning mathematics leads to the achievement of many educational aims, (Al Harbi, 1994).

Characteristics of good writing

Researchers have concluded the following six characteristicsof good writing:

1. Content which is related to the accuracy, validity and comprehensiveness of the topic learners write about.
2. Organization thatis related to the sequence of the writer's ideas and the presentation strategy he chooses to present ideasto suit the reader or listener.
3. Word choice (vocabulary) where words are chosen accurately to fit the topic about which the student is going to write.
4. Sentence fluency which is related to the structure of sentences in accordance to length, shortness, type and connection between them.
5. Character that is related to highlighting the writer's character or personal elements. The reader sometimes distinguishes between writers through their writing styles whether literary, scientific or cultural.
6. Writing conventions that are related to spelling, grammar and punctuation.

Genesis of the project

The idea of the project-based strategy in education refers to the educators of the18th and 19th century such as Rousseau, Bastalutzi, Herbert and Frobel who called for the child's freedom and appropriate placement in the process of education. in addition, they called for treating the learner as the center of the activity around which revolve the efforts of educators and teachers. Educators, from those days,began to think about the means by which aims of education can be achieved.The efforts of John Dewey in this field represent the achievement of the recent ideasfor which educators of the 18th and 19th centuries called. Dewey's works and educational efforts brought to life the views of those educators to experience tests. So it is not surprising if the modern educational strategy is considered asthe summary of Dewey's philosophy, especially that aspect related to the linkage between school and community. Dewey believes that school is no longer a place to prepare children for life by providing them with some abstract materials and facts. School is actually a place where children live a real social life that trains them to solve life problems they encounter outside.For this sake, Dewey stressed the importanceof making school environment as a place that allows the child to feel that he is not living in a surrounding where his attitudes are suppressed and his wishes can not be fulfilled. Thus, he stressed the need to introduce practical lessons at school. His remarkable saying " Learning by Doing" has reached every modern school. It has dominance over the ideas of most

Print ISSN: 2054-6351, Online ISSN: 2054-636X

teachers and educators. Nowadays, schools do not lack some of the commercial, industrial or agricultural works. Such saying is considered the nucleus for the project-based strategy in teaching, (Mar'i & AbuSheikhah, 1996).

The project is not a new event. Life is full of projects as long as human beings make do their best to solve difficulties theyencounter. It is a work of life that the individual implements. So, when we talk about the project-based strategy in education as an organized scientific strategy, we try to link school education with the learner's life inside and outside, i.e. we hope to connect the learner's school environment with his social one, (Al Hila, 2000).The project-based strategy, as a teaching strategy, can be considered as one of the most important student-centered teaching strategies. It is really one of the most systematic scientific strategies that link theory and practice. It strengthens and links the student's relationship to the social and economic life of his community, (Hassanein, 2007).The project usually transfers the student from theory to practice.It translates ideas and visions into actions that, in turn,make teaching and learning vital and in the same time, achieves the aims. Itstresses the principle of job- related functional learning. It, more importantly, links science, work and study to the learners' lives environment and local community, (Al Nashef, 2009).

The concept of the project

Educators, before Kilpatrick, were in disagreement about the definition of the project-based strategy. The term "project" was earlier used by scientists of practical farming and engineering in experimental agricultural fields in America. Then it was transferred to schools. The meaning of"project"was gradually determined and lastly defined by Kilpatrick as "The purposeful activity that takes place in a social setting and a framework of life". In other words, it is a purposeful action with defines aims andlife-related activities carried out by a group of educated individuals under school supervision and follow-up", (Abu Zeina, et.al. 2004:75). Besides, project-based learning is a set of complex tasks based on a problem or issue that challenges the thinking of the learner where he practices the skills of problem solving, decision-making, surveying, writing, oral presentations, dialogue, and reflection. It, relatively takes time longer than the usual classroom time that ends up with real outcomes and diverse presentations. The teacher, through the project-based learninghopes to teach main concepts and content and becomes as a learningguide and facilitator", (Thomas, et.al., 1999).

In short, project-based learning means "learning via experience", where students are divided into groups to solve problems that challenge them. These problems should be real, interdisciplinaryand derived from curriculum.Teachers should determine the perspective to be adopted for the solution and activities to be used. Information is gathered from various sources and then integrated and analyzed. Concluded knowledge by learners makes learning valuable and meaningful as it is related to something real and involves skills such as cooperation and thinking. At the end, students present their newly acquired information and evaluate knowledge they have acquired in addition to the strategy they used to communicate information. During this process,the teacher's role is restricted to guidance and advice instead of directing and managing student's work, (Solomon, 2003).

Studies related to project-based strategy and academic achievement

Boaler (2002) studied the achievement of students who learnt mathematics via project-based learning strategy and the traditional strategy in two schools that follow the British curriculum.Findings showed that there were significant differences in both groups'

Print ISSN: 2054-6351, Online ISSN: 2054-636X

achievement in favor of those students who were taught by the project-based learning skill. An increase in their mathematical ability was also noticed.Gibson (2008) aimed to find out the effect of exercises and skills practice via using multiple intelligences according to the project-based learning strategy on the achievement of sixth graders in mathematics. Results indicated that a remarkable improvement in students' achievement in mathematics. The results also revealed that the project-based learning strategy was an effective way of teaching mathematics.McClurg (2009) aimed to identify the impact of using project-based learning strategy to improve students' achievement in reading and language arts in the intermediate schools in Georgia, USA. The experimental group consisted of (45) students who were socially and economically deprived and were taught according to the project-based learning strategy. The control group involved (42) participantswho were not socially and economically deprived and were taught by the traditional strategy. The results indicated that the achievement of students in the experimental group improved much better than their peers in the control group.

Studies related to the mathematical writing

Johanning (2000) investigated the importance of writing as a special strategy to help students think mathematically in addition to using writing as a means of dialogue between the teacher and his students. Qualitative analysis was used to understand students' thinking style as an entry to problems describing how they solved eachone. Findings revealed that writing provided a strategy for students to learn mathematics as they communicated their ideas through written papers to their colleagues. Mathematical writing increased the student's confidence in solving the problem within the group by enabling them to develop ideas that they shared the group in which they worked. Each student benefited from his colleague in the group more than he benefited from the teacher.Diffily (2001) designed projects related to the environment surrounding the school, such as trees observation, aquatic environments and others.Students were asked to write reports, posters and guidesand read books on these subjects. They also wrotepropaganda posters and directives. Students in other classes used traditional ways in learning reading and writing. Results revealed that the project-based strategy was more effective in improving the reading and writing abilities of participants in the experimental classes.Mataryah (2009) studied the impact of project-based learning strategy in solving problems and mathematical writing among middle school students in Saudi Arabia. The teaching material was presented to the experimental group through the project-based strategy whereas the control group was taught by the traditional strategy. Results showed a significant difference in participants' abilities regarding problem solving and mathematical writing skills in favor of project-based learning strategy.

In conclusion, most of studies and research in the area of using project-based strategy in teaching to improve and enhance students' academic achievement and varied learning abilities or skills have proved its positive effect to do so.However, very few studies have dealt with the project-based learning strategy in general, and particularly in mathematics in the Arab world.Therefore, the present study can beof the first attempts to give a clearer picture of the effectiveness of the project-based learning strategy in the field of mathematical writing and achievement. It hopes to enrich the existing studies and shed light on its impact on developing Saudi university students' abilities and achievement in mathematics.

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METHODOLOGY

Study approach

The quasi-experimental approach was used to test the effectiveness of the project-based learning strategy in improving the mathematical achievement and writing of preparatory year students at Najran University.Table (1) shows the design of the present study.

Table 1: *Study design*

Group one	A1	X1	O1	O2
Group two	A2	XO	O1	O2

A1: Previous achievement of participants in mathematics X1: teaching by project-based strategy

XO: teaching by traditional strategy O1: post achievement test

O2: mathematical writing test

Participants

Fifty students were chosen from the students enrolled in the "Introduction to Mathematics" course in the second semester at Najran University in the academic year 2016/2017. Participant students were divided into two equal groups of (25) students in each. One group was assigned as the experimental group and taught via the project-based learning strategy.The other group was referred to as the control group and received their learning through the traditional teaching strategy. To check homogeneity of participants in both groups, mean scores and standard deviations of their grades in the General Secondary Examination were used. T. test was used to compare between these mean scores and check whether there were any significant differences between both groups. Results are shown in table (2).

Table 2: *homogeneity of participant students in the experimental and control groups*

Results in table (2) reveal that there were no statistically significant differences (α=0.05) between the mean scores of students in both groups. In other words, the two groups were homogeneous in accordance to their grades in the General Secondary Examination.

Study instruments

The teaching material

The teaching material that was delivered to studentsin the present study consisted of all the teaching units included in the "Introduction to Mathematics" course that was offered to all students at the preparatory year at Najran University in the second semester of the academic year 2016/2017.

Teaching plans

The teaching plans for the topics included in the "Introduction to Mathematics" course were developed in accordance to the project-based strategy and were used while teaching the experimental group. While the control group was taught via the traditional strategy and so no modifications were made to the teaching materials.Theseteaching units and plans were

Print ISSN: 2054-6351, Online ISSN: 2054-636X

presented to a group of specialist arbitrators in the field of mathematics methodology to ascertain their fitness for the content of the educational material. Modifications, by addition or deletion, were made and consequently four teaching projects were presented to students in the experimental and control, namely the linear equations and their applications, linear inequalities, equations containing absolute value, and quadratic equations.

The achievement test

After the determination of the teaching material, an achievement test was developed to test participant students' academic achievement. The test in its initial format consisted of (50) items and aimed to test students' achievement in the four topics of the "Introduction to Mathematics" course. After that it was presented to the same group of arbitrators to ascertain its validity and fitness to the course's teaching material and aims. Required modifications were done as arbitrators recommended and so the test in its final format included (45) items. The achievement test was at first carried out on a pilot sample of (10) students who were enrolled in the "Introduction to Mathematics" course but not were participating in the present study. Cronbach Alpha was used and find out that the correlation coefficient was (0.81) which means that it was valid and reliable to be used in the present study.

The mathematical writing test

As soon as the teaching material and the achievement test were developed, the second test, i.e. the mathematical writing test was developed. the test in its initially version consisted of (30)multiple choice items. Then it was presented to the specialist arbitrators who checked the appropriateness of the teaching material and the achievement test. After revision according to their views, (10) items were excluded and so the final version of the test consisted of (20) multiple choice items. The test was applied to a pilot sample of (10) students of the preparatory year students who were not taking part in the study.The time needed was estimated by (75) minutes.Using Cronbach Alpha, the correlationcoefficient was calculated and was (079). Difficulty coefficients and ability to distinguish for each question were also calculated. Results are presented in table (3).

Table 3: ***Mathematical ability test items difficulty coefficients and ability to distinguish***

Question Number	Difficulty Coefficient	Ability to Distinguish
1	0.57	0.44
2	0.53	0.50
3	0.50	0.44
4	0.62	0.56
5	0.57	0.44
6	0.53	0.44
7	0.38	0.62
8	0.57	0.44
9	0.47	0.62
10	0.38	0.56
11	0.73	0.44
12	0.81	0.39
13	0.73	0.39
14	0.73	0.44
15	0.38	0.56
16	0.67	0.44
17	0.38	0.50
18	0.64	0.39
19	0.67	0.44
20	0.38	0.65

Print ISSN: 2054-6351, Online ISSN: 2054-636X

RESULTS

Results related to the first question

To test whether there wasany statistical difference in the academic achievement in mathematics of the preparatory year students at Najran University due to the project-based learning strategy, mean scores and standard deviations of participants' grades on the achievement test in the experimental and control group were extracted. Results are presented in table (4).

Table 4: ***Mean scores and standard deviations of participant students' grades in the experimental and control groups on the achievement test***

Group	Number of Participants	Mean Score	SD
Control	25	11.3	2.9
Experimental	25	15.4	3.4

Table (4) shows that there was an apparent difference between the mean scores of participants' grades in the experimental group that was taught by the project-based learning strategy and the mean scores of their peers' grades in the control group that learnt by thetraditional strategy on the achievement test. General mean score of participants' grades in the experimental group was (M=15.4) and the standard deviation was(3.4).On the other hand,general mean score of participants' grades in the control group was (M=11.3) and the standard deviation was (2.9). To test whether this apparent difference between the general mean scores of both groups is statistically significant, ANCOVA was used. Findings are presented in table (5).

Table 5: ***ANCOVA for participant students' grades on the achievement test***

Source of Variance	Sum of Squares	DF	Mean of Squares	F. Ratio	Significance
General Secondary Exam	12.6	1	12.6	0.6	0.378
Group	1015.8	1	1015.8	49	000
Error	975.0	47	20.7		
Total	2017.0	49			

Table (5) indicates a statistically significant difference ($\alpha = 0.05$) between the general mean scores of participants' grades in both groups in favor of the experimental group. For the purpose of determining in favor ofwhich group the significant difference was, mean scores of students' grades in the experimental and control groups were converted into modified mean scores. Table (6) shows the results.

Table 6: ***Modified mean scores and standard errors for participants' grades in both groups on the achievement test***

Group	Mean score	Standard error
Experimental	16.1	0.7
control	11.7	0.8

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Table (6) reveals that the significant difference between the modified mean scores of participants' grades in the experimental and control groups on the post-achievement test was in favor of the experimental group. Modified mean score of the grades of students in the experimental group was (M=16.1), while the modified mean score of students" grades in the control group was (M=11.7).In other words, there was a statistically significant difference between the mean scores of students' grades in the experimental group and the mean scores of their peers in the control group on the achievement test. That difference was in favor of students in the experimental group who learnt the teaching material of the "Introduction to Mathematics" course via project-based strategy.

Results related to the second question

To test whether there was any statistical difference in the mathematical writing skill of the students at the preparatory year at Najran University due to the project-based learning strategy, mean scores and standard deviations of participants' grades on the mathematical writing test in the experimental and control group were extracted. Results are presented in table (7).

Table 7: ***Mean scores and standard deviations of students' grades in the experimental and control groups on the mathematical writing test***

Group	Number of students	Mean score	Standard deviation
Experimental	25	16.5	4.2
Control	25	8.2	5.4

Table (7) shows that there was a significant difference between the general mean scores of participants' grades in the experimental group who studied by the project-based learning strategy and the control group who studied by the traditional teaching strategy on the overall mathematical writing test. General meanscore of participants' grades in the experimental group was (M=16.5) and the standard deviation was (4.2). On the other part, generalmean score of participants' grades in the control group was (M=8.2) and the standard deviation was (5.4).To determine whether this difference between the mean scores of both groups was significant (α=0.05), ANCOVA was used.Results are shown in Table (8).

Table 8: ***ANCOVA for students' grades in the two groups on the mathematical writing test***

Source of variance	Sum of squares	DF	Mean of squares	F. Ratio	Sig.
General Secondary Exam	65.3	1	65.3	2.6	0.074
Group	6458.3	1	6458.3	257.3	0.000
Error	1179.8	47	25.1		
Total	7687.5	49			

Table (8) indicates a statistically significant difference (α = 0.05) between the general mean scores of participants' grades in both groups in favor of the experimental group. To understand in favor of which group the significant difference was, mean scores of students' grades in the experimental and control groups were converted into modified mean scores. Results are presented in table (9).

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Table 9: ***Modified mean scores and standard errors for participants' grades in both groups on the mathematical writing test***

Group	Mean score	Standard error
Experimental	16.1	0.8
Control	7.9	0.7

Table (9) reveals that the significant difference between the modified mean scores of participants' grades in the experimental and control groups on the mathematical writing test was in favor of the experimental group. Modified mean score of the grades of students in the experimental group was (M=16.1), whereas the modified mean score of students' grades in the control group was (M=7.9). In other words, There was a statistically significant difference between the mean scores of students' grades in the experimental group and the mean scores of their peers in the control group on the mathematical writing test. That difference was in favor of students in the experimental group who learnt the teaching material of the "Introduction to Mathematics" course via project-based strategy.

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