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The Effect of Project-Based Learning and the ARCS Motivational Model on Students' Achievement and Motivation to Acquire Database Program Skills

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Abstract
This quasi-experimental study aimed to measure the impact of project-based learning and the ARCS motivation model on students' motivation to acquire the necessary database applications skills in the secondary level. We adopted a quasi-experimental methodology based on pre- and post-tests for two groups of students. Two classes of the second secondary grade were selected, one to be the experimental group and the other representing the control group. A sample of 65 students was chosen and divided into two classes enrolled in the second secondary grade. We explained the database programs to the students in the control group using traditional teaching methods, which involve the teacher first explaining the concepts, and then giving the students the opportunity to apply their practical computer skills in the laboratory. Students in the experimental group were taught using project-based learning strategies. At the beginning of the semester, students were given projects that they needed to complete by the end of the course. In addition, the ARCS motivation model was applied to the subject matter, whereby additional subject matter was added to the student book, making the database sections more attractive and relevant to the students by including real-life examples. The results showed that students in the experimental group (the project-based learning group) achieved higher post-curriculum test grades and obtained higher grades on the motivational scale.
Keywords: Project based learning, teaching, secondary education, teaching/learning strategies, ARCS Model

1. Introduction

Computer teachers in secondary level schools face various difficulties when using traditional teaching methods to deliver concepts related to database programs and applications to students. Students have trouble linking the theoretical database concepts with their practical real-life applications. Changing a theoretical problem into a practical solution using these applications is challenging because of the lack of correlation between the theoretical study of these concepts and their actual real-life application. This could negatively affect the students' motivation to learn, or to acquire new database program skills.

An alternative way to teach database applications to students in secondary levels is through project-based learning. This learning method incorporates ideas from the constructivist theory of learning, which bases the learning process on students' actual capabilities, enabling them to acquire the necessary skills and knowledge. This model focuses on the students applying what they have learned from realistic, descriptive projects, which increases the link between theoretical database concepts and their real-life applications.

The ARCS motivation model (Keller, 2000) is one method used to motivate students to learn database applications. ARCS refers to Attention, Relevance, Confidence, & Satisfaction. When ARCS motivation model strategies are combined with teaching design, there is a high probability of increasing students' motivation to learn (Cheng & Yeh, 2009; Keller, 2000; Small, 1997). In addition to the use of ARCS strategies, we have used a motivation scale in this study to measure students' levels of motivation to learn database applications using the project-based learning method. Using ARCS strategies, containing ARCS model elements, means using subject matter other than that in the textbook. Studies have shown that students' motivation towards learning in the classroom is one of the main factors affecting students' performance (Gottfrieed, Fleming & Gottfried, 2001; Gottfried, Marcoulides, Gottfried, Oliver & Guering, 2007).

1.2 Theoretical Framework

The lecture-based teaching method developed from the behavioral theory of learning (Ellis & Berr, 2005). According to this method, the teacher is the information provider, and the student's role is limited to listening and completing exercises provided by the teacher. The teacher organizes facts and skills, and provides them to the student, who must work to master them. Students can usually master the required skills and apply them in a given context, but when the context is changed, students are no longer able to apply the acquired knowledge. By comparison, project-based learning is a learning method which is based on the constructivist theory, which focuses on the need to engage the student in a course of educational activities, and depends on the student's active participation. The student learns in different contexts, which enhances the applicability of what he or she

has learned.

This study also addresses students' motivation levels. In previous teaching theories, motivation was viewed as the individual's desire to succeed, but more recently the individual's motivation is seen as his or her conception of success ability and success value (Kloosterman, 1997). This perception of motivation is called the Expectancy-Value theory. Studies have indicated that one of the most important factors adversely affecting students' performance is their low motivation to learn during the school stages. The ARCS model is considered one of the most important methods by which students' motivation to learn is increased. This model can be incorporated into the project-based learning method to increase students' motivation levels and raise their knowledge acquisition levels.

2. Literature review

In addition to practical training, lecturing is considered the primary method of providing students with computer skills. Steps are followed and skills are taught in a logical sequence so that the student can apply them as he or she learns them. The teacher plays a key role in this method, as the provider of skills to the student. The student's role is limited to writing information down and applying it to computer-based tasks (Santrock, 2008). This perception of teaching stems from the Thorndike method, whereby skills are taught to the student, and the student, in turn, practices the acquired skills. Thorndike believed in the need to order and organize the skills logically, and then teach them to the students in that order. The students practice until they master the skills (Ellis & Berry, 2005). Thorndike's theory has been widely applied in the teaching of mathematics and similar courses.

The project-based learning approach derives from the constructivist theory developed by Jean Piaget. Piaget believed that students can be provided with information directly, but to understand and use such information in a real life context, the student needs to build his own experience (Powell & Kalina, 2010). Piaget also found that students learn new skills and information in the context of previous information, and use both previous and new information to develop new knowledge. Piaget considered learning to be an ongoing process in which the learner reviews what he knows to develop new knowledge.

In this context, researchers in the educational field emphasize the importance of teaching to understand, not teaching to memorize, and teaching in the context of problem solving (Bremer & Morocco, 2003). In computer science, teachers are required to illustrate abstract concepts to the student. Thus, the computer science teacher should exert extra effort to assist students to understand the concepts, rather than draw algorithms and recite software rules for students to memorize (Even & Kvatinsky, 2009).

When designing strategies that promote comprehension and understanding, it should be remembered that learning comes from exploration. Students learn by using their own knowledge to solve problems. This improves their comprehension and motivation. Bruno is one of the most prominent scholars on the subject of learning through exploration (Brunstein, Betts, & Anderson, 2009). Learning through exploration is a learning style that focuses on students' own work and activities. The student becomes the center of the learning process, and the teacher's role is limited to directing and guiding students (Kyriazis, Psycharis, & Korres, 2009). In exploration-based learning, the student is encouraged to take risks and commit errors, and teacher uses these situations to improve the learning process. In addition, students' understanding of the subject matter deepens, by being encouraged to apply the acquired knowledge to new problems.

Project-based learning is an exploration-based learning model where students are actively engaged in learning new concepts through individual or collaborative work on projects related to the subject matter. According to Blumenfeld (1991), project-based learning combines active learning and student motivation in the same system. The teacher engages students in the learning process through classroom projects that require exploration. By using high-quality classroom projects, students perform functions similar to real-life situations and relevant to their daily lives, which increases their motivation and thus their academic achievement (Van Ryzin & Newell, 2007). By using projects that resemble real life, the students are able to understand the importance of what they are learning while participating in the learning process more actively than they do using traditional teaching methods.

Researchers suggest that working in interactive and cooperative groups to resolve problems helps students to develop their skills, thus positively affecting their skills before graduation. Learning through projects, individually or collectively, helps students to apply what they have learned in real life, because this method of learning requires the use of multiple sources of data, in addition to cognitive student tools (Blumenfeld, 1991). Boaler (2002) showed that in addition to positive academic outcomes, the project-based learning experience reduced anxiety among students who were learning complex issues and engendered a positive attitude toward learning. In project-based learning, students deal with concepts in the context of their application in real life, resulting in a deeper understanding of complex concepts.

2.1 ARCS motivational model for lesson design

Dr. John Keller designed the ARCS Motivational model for lesson design in the mid-eighties. Keller stipulated

four requirements for the curriculum, to help teachers increase students' continuity and motivation. Many studies have shown the effectiveness of this model when it is applied in the classroom (Chyung, 2001; Means, Jonassen & Dwyer, 1997; Gabrielle, 2003). The literature thus provides support for the credibility of the ARCS model in the educational context.

Chyung (2001) explored the reasons why students dropped out of an e-course, and tried to find solutions to the problem encountered. Students dropped out of the course for the following reasons: students were not interested in the course content; students were not confident in the e-learning environment; and students were not convinced of the effectiveness of education in an e-learning environment. To overcome these obstacles, Chyung redesigned the e-course based on the ARCS motivational model to make the course more interesting and relevant to students' concerns, which increased the students' confidence and conviction in the course. The study results showed that the students became more confident and convinced of the relevance of the course, which was reflected in their academic results. The course dropout rate was reduced by half.

Gabriell (2003) aimed to have a positive impact on students' motivation, performance, and self-teaching in a military college. The researchers conducted a pilot study on a sample of 250 students divided into two groups, an experiment group and a control group. The control group was taught using the traditional lecture method, whereas the experiment group used courses designed according to the ARCS model, where educational subject matter included motivational messages and examples from real life. The study results showed a high level of motivation in the experimental group. Means, Jonassen & Dwyer (1997) conducted a study on a sample of 110 statistics students. A control group used the traditional lecture method whereas the experimental group designed a statistics course containing exercises and training relevant to the students' real lives. The study results showed that the experimental group excelled academically and showed higher levels of motivation towards learning.

Iguchi & Suzuki (1996) conducted a pilot study using two different versions of mathematics learning software for the ninth grade. The control group used the educational software version, which did not contain messages or any other content to improve motivation, whereas the experimental group used a software version that had been designed according to the ARCS model, and included examples and exercises relevant to the students' lives. The results showed significantly higher motivation levels in the experimental group. The results also showed that the experimental group excelled in understanding and knowledge of the mathematical concepts, compared to the control group.

According to Small (1997), if teachers maintain a high motivational level in classroom, students' levels of academic achievement are more likely to improve. Small agreed with previous studies in that the ARCS model is easy to apply and effective in motivating learners. The ARCS model is based on four main pillars, the first three of which (attention, relevance, and confidence) are important in creating motivation to learn, and the fourth (satisfaction or conviction) is important to make learners feel confident and satisfied with what they have learned. What follows is an explanation of these four pillars:

- 'Attention' means getting the students' attention and arousing their curiosity at the beginning of and throughout the lesson. Although it is relatively easy to get the students' attention at the beginning of a lesson, continuity is difficult. Keller (2010) suggested several strategies to get students' attention and keep it, including instigating unexpected events during the class, or starting the lesson with a problem relevant to the students' lives.
- 'Relevance' means linking the ongoing learning process to something that is important to students, such as their hobbies, interests, or future goals (Keller, 2000). In this study, a project is used to help students to form a relationship with what they have learned.
- 'Confidence' means that the students should maintain a degree of confidence in their eventual success to have sufficient motivation to learn. In project-based learning, confidence can be instilled in the student by telling him that he can complete the project with his colleagues, and that he does not bear full responsibility for the project.
- 'Satisfaction' refers to the positive feeling that the student experiences when completing a class task. This pillar can be applied to the project-based method, to measure the students' sense of satisfaction upon completing the project correctly.

The inclusion of these four pillars or requirements in the ARCS teaching model enhances students' motivation in the classroom. According to Huett (2006), the ARCS model is an attempt to synchronize the cognitive and behavioral theories, to prove that subject-matter design can influence students' motivation levels. After an extensive review of studies, we found that few studies combine project-based learning and the ARCS motivation model, whereas many studies prove the effectiveness of the ARCS model and project-based learning separately (Cavendish, 2010; Mansfield, 2010; Ricks, 2009).

3. Problem statement

This study aims to address the failure of traditional teaching methods to deliver database applications concepts successfully to students in the secondary level. Previous studies have not investigated whether project-based

teaching strategies, used in combination with ARCS model strategies, have an impact on students' motivation levels and their acquisition of database program skills. It is thus not known what impact the project-based teaching model has on students' acquisition of database program skills. In this study, we measured the impact of the project-based teaching method on students' acquisition of database skills, as well as the effect of the ARCS motivation model on their motivation levels towards learning, in comparison with traditional teaching methods.

4. Objective

This quasi-experimental study measures the impact of project-based learning and the ARCS motivation model on students' motivation and acquisition of database applications skills in the secondary level.

5. Questions and Hypothesis

This study attempts to answer the following questions:

Question 1: Is there a statistically significant difference between the averages of students' grades in the database program knowledge acquisition test between the group using traditional teaching methods, and the group using the project-based learning method? (Independent variable: teaching method; dependent variable: students' averages in knowledge acquisition test)

Null Hypothesis: There is no statistically significant difference in students' knowledge acquisition between students taught with the traditional method and those taught using the project-based learning method.

Question 2: Is there a statistically significant difference in students' motivation towards learning between the group using the traditional teaching methods, and the group using the project-based learning method? (Independent variable: teaching method; dependent variable: the student's grade in the subject-matter motivation scale).

Null Hypothesis: There is no statistically significant difference in motivation between students taught with the traditional method and those taught using project-based learning.

6. Importance of the Study

The study provides curriculum designers with alternative methods for the design of database lessons in computer courses. The study determines whether the project-based learning method is appropriate for teaching database applications in secondary levels. The study aims to fill the gap in the literature regarding the integration of the project-based learning model and the ARCS motivation model, particularly with regard to the use of this method in computer concepts teaching.

7. Methods

This study used a quasi-experimental approach based on pre- and post- tests for two groups. This quasi-experimental approach is used in quantitative educational studies when it is problematic to distribute subjects randomly between the experimental and control groups. Two classes of the second secondary grade were selected, one the experimental group and the other the control group. To ensure equivalence between the two groups regarding previous experience in database program use, we conducted a pre- test. The results showed no statistically significant differences between the groups in prior database application knowledge.

7.1 Study population and Sample

The population consisted of all students in the second secondary grade in the city of Riyadh. We chose a sample of 65 students divided into two classes and enrolled in the second secondary grade in the Prince Sultan Educational Complex.

7.2 Experimental Treatment

At the beginning of the semester, students in the control and experimental groups completed the same pre-test to ensure equivalence between both groups. Below is a review of the differences in experimental treatment between the experimental and control group:

7.3 Control Group: we used traditional teaching methods to explain the subject matter, which involved the teacher explaining concepts, and then giving students the opportunity to apply the concepts practically on their PCs in the computer lab. The teacher used the prescribed textbook to explain the concepts.

7.4 Experimental group: this group was taught using the project-based learning strategy. At the beginning of the semester, the students were given projects to be completed by the end of the course on database applications. In addition, the ARCS motivation model was applied to the academic subject matter that students learned. Additional subject matter was added to the prescribed textbook, making the subject matter more attractive and relevant to the student, including real-life examples of database usage. The amended matters included feedback to make the student feel more confident and satisfied with what he or she had learned.

At the end of the semester, we gave the post-test, which was an exact copy of the pre-test, to the students. We also measured the students' motivation levels for the academic subject matter using a motivation-measuring tool. The curriculum included the following database topics:

1 Creating tables
2 Entering and modifying data fields
3 Field properties
4 Queries
5 Forms
6 Sub-forms
7 Reports

8. Study Tools

8.1 Pre- and Post-Tests

We designed a pre- and post-curriculum test consisting of 20 items for both the experimental and control groups. The test measured the extent of students' comprehension of the database concepts, and of the Access program.

8.1.1 Test validity and reliability:

An alpha coefficient of 0.72 was calculated for the pre-curriculum test at the beginning of the semester. In addition, the test was submitted to three computer science teachers to assess the curriculum validity and reliability.

8.2 Motivation Measure

We used a motivation measure tool called Subject-Matter Motivation Measure, designed by Keller (2000). It consists of 36 items to which students respond on a Likert scale with four levels, ranging from "not true" to "completely true". The test in its English version has an alpha Cronbach factor of 0.96. The tool was translated and presented to four members of the teaching body in the Department of Curriculum and Instruction to make sure of its linguistic accuracy and vocabulary clarity.

9. Results & Discussion

The first question to be answered was: is there a statistically significant difference between the averages of the students' grades in the database applications achievement test between the group that used traditional teaching methods and the group that used the project-based learning method (independent variable: teaching method; dependent variable: students' grades in the achievement test).

To answer this question, an analysis of variance (ANOVA) was used to indicate whether the difference between students' grades in the experimental and control groups was statistically significant. Table 1 shows the means and standard deviations of the students' grades in the two groups. The control group using the traditional learning method in the post-test obtained mean score of 13.23 with a standard deviation of 1.54, whereas for the experimental group the mean grades of the post-test was 17.85 with a standard deviation of 0.98.

Table 1. Students' Grades in the post-curriculum test

Group	N	M Highest grade= 20	SD
Control Group (traditional learning)	33	13.23	1.54
Experimental Group (project-based learning)	32	17.85	0.98

To identify the significance of these differences in the students' mean averages, Table 2 shows the results of the analysis of variance. The table shows that these differences are statistically significant in favor of the experimental group $F(1.63) = 6.086$, significance level<0.05. The effect size is 0.47, which is less than the moderate level.

Table 2. Analysis of Variance (ANOVA) of differences between students' grades means in the post-test

Source of variance	sum of squares	Degrees of Freedom	Mean squares	F	Significance Level P	Effect Size η^2
Between Groups	5426.21	1	5426.21	3.086	0.016	0.47
Within Groups	54872.24	63	745.25			
Total	52547.68	64				

The second question in the study was: is there a statistically significant difference in students' motivation towards learning between the group that learned using traditional teaching methods and the group that used the project-based learning method (independent variable: teaching method; dependent variable: grade obtained by the student in scale of subject-matter motivation).

Table 3 shows the means and standard deviations of students' grades for the Subject-Matter Motivation scale. The table shows that the experimental group, taught using the project-based learning method, obtained higher results (mean score of 81.32 with a standard deviation of 1.25) than the control group (mean score of 113.8 with a standard deviation of 1.41)

Table. 3 Students' points Statistics on the motivation scale

Group	N	Mean Highest point = 20	SD
Control Group (traditional learning)	33	81.32	1.25
Experimental Group (project-based learning)	32	113.80	1.41

To identify the significance of the differences in the students' mean grade on the motivation scale, Table 4 shows the results of the analysis of variance test. The differences appeared to be statistically significant in favor of the experimental group $F(1.63) = 13.157$, significance level<0.00. The effect size was 0.62, which is considered moderate

Table 4. Analysis of Variance ANOVA of differences between students' grade averages on the motivation scale

Source of variance	sum of squares	Degrees of Freedom	Mean squares	F	Significance Level P	Effect Size η^2
Between Groups	25874.25	1	25874.25	13.157	0.000	0.62
Within Groups	84574.21	63				
Total	92357.84	64				

This study investigated the impact of project-based learning and the ARCS motivation model on students' performance and on their motivation to learn database applications. The analysis of variance of the differences between students' mean grades in the control and experimental groups showed that the experimental group students, using the project-based learning method, achieved higher grades. This is consistent with the results of previous studies that confirmed the effectiveness of project-based learning to improve students' academic achievement (Van Ryzin & Newell, 2007; Blumenfeld, 1991; Boaler, 2002).

The second question investigated the impact of the ARCS model on students' motivation levels. The results of the analysis of variance of the differences between students' grades on the motivation scale showed statistically significant differences between the experimental and the control group, in favor of the experimental group. The results are consistent with previous studies that showed the effectiveness of using the ARCS model in course design and in increasing students' motivation towards learning (Chyung, 2001; Means, Jonassen & Dwyer, 1997; Gabrielle, 2003; Iguchi & Suzuki, 1996).

This study integrates the project-based learning method with the ARCS motivation model. According to our results, the integration of the project-based learning method with the ARCS motivation model results in an increase in students' academic performance and acquisition of database program skills, as well as an increase in students' motivation toward learning.

10. Recommendations

Based on the study findings and results, we make the following recommendations:

1. The computer curriculum should be redesigned to include practical projects to be performed by students either in small groups or individually.
2. The four pillars of the ARCS model (Attention, Relevance, Confidence, and Satisfaction) should be included in the design of computer courses.
3. Classroom teachers and teachers working on project-based learning strategies and the ARCS motivation model should be trained accordingly.
4. This study was conducted on a sample of male students, and it would be useful to investigate the impact of the experiment on female students.
5. To identify the impact of project-based learning and the ARCS motivation model on other computer skills, we recommend conducting similar studies to identify the effectiveness of these techniques in the development of other computer skills, such as spreadsheets, programming, and design.

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