

## **Effects of Instructional Methodologies on Student Achievement, Attitude and Retention**

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### **Abstract**

The purpose of this study was to compare the effectiveness of two different methods of instruction for mathematics - the project-based experiential learning method and the traditional classroom method. The objectives focused on student achievement, attitude toward instruction, and retention of knowledge and skills.

The study was conducted over three months to include units of instruction in surface area and volume and coordinate geometry. Seven intact classes (95 students) at a private school in central Pennsylvania participated in the study. Students entered the study having demonstrated similar levels of prior performance.

Survey instruments were developed to assess students' attitudes toward the method of instruction. Commercially produced mathematics exams were modified to assess levels of student achievement.

The data shows that students taught through the traditional classroom method produced higher achievement scores immediately following the unit of instruction. Students taught through the project-based method of instruction had a greater level of retention as indicated by scores on the posttest taken three weeks after the last unit of instruction.

Students' attitudes toward instruction suggest that the sequence of instructional methodologies may have an affect on attitude. The first unit of instruction suggested that those students in the project-based method of instruction had a more positive attitude toward the method of instruction. The second unit of study indicated the traditional classroom method of instruction produced a more positive attitude toward instruction for those students involved.

Results of this study generally support previous research regarding the value of both the project-based and traditional classroom instructional methodologies. The study suggests that the value of these methodologies lies in the ability of instructors to combine the strengths of these strategies, from year to year, to best address their current student body.

### **Introduction**

Teachers continually face the difficult challenge of providing a high-quality educational experience that produces a highly competitive, well-balanced, successful student while answering to public perception and increased professional demands. Published results of numerous local, regional, national, and international assessments keep our educational system under continual public scrutiny. At the same time, education continues to be the driving force to a sound economy and a society that is both prosperous and safe in the global community. This

education does not come cheaply in terms of time and money needed to support its expected success.

Scholars have long searched for methodologies, strategies, and techniques that best enable the learner to take-in and utilize knowledge and skills. Fogarty (1999) identifies a number of "educational architects" that brought their philosophies and research to the forefront of the educational experience. Fogarty uses these researchers as a foundation for explaining that the design of learning must empower the learner to make meaning through the mindful manipulation of input. Caine and Caine (1991) explain that natural knowledge is not the equivalent of absolute truth. Hence, it is important for educators to continually push for an expansion of students' frames of reference.

The traditional classroom method of instruction is a familiar practice in many schools. Hiebert (1999) finds the traditional approach to solving problems in U.S. classrooms is to teach a procedure and then assign students problems on which they are to practice the procedure. Problems are viewed as applications of already learned procedures. This method of instruction allows instructors to cover a greater breadth of material in a shorter period of time (Buck Institute of Education, 1999).

John Dewey (1933) found that training with isolated exercises leaves no deposit, leads nowhere; and even the technical skill acquired has little radiating power or transferable value. It is not enough to learn from our experiences. What matters is how the experience is used (Caine and Caine, 1991). Project-based learning is an instructional methodology that promotes the use of experiences to develop new learning. The goal of a project is to learn more about the topic rather than to seek answers to questions posed by a teacher. Project-based learning is designed to be an integral part of the curriculum (Katz, 1994), where students receive a real or a potentially real problem and devise practical solutions from the research they do.

### **Purpose/Objectives**

The purpose of this study was to compare the effectiveness of two different methods of instruction for mathematics. One was the project-based experiential learning method used in the Agricultural and Environmental Education program and the other was a more traditional classroom method of instruction. These two approaches were studied for their effects on student achievement, attitude toward instruction, and retention of knowledge and skills. Jacob (1984) relates Piaget's position that a key factor in the development of knowledge is physical experience, the interchange the child has with the physical environment. This research provides new knowledge that will aid in determining effective methods for planning and delivering instruction to students at Milton Hershey School.

The objectives of the study were to determine:

1. To what extent there is a difference in student achievement and retention test scores between students taught a unit of mathematics by a project-based experiential learning method versus a traditional classroom method of instruction in mathematics.
  - a. Student achievement differences as indicated by unit test scores immediately following the individual units of study.

- b. Difference in the extent of the retention of skills and knowledge as indicated by a long term posttest administered three weeks after the completion of the last unit of study.
2. To what extent there is a difference in the attitudes of students toward learning when taught by a project-based experiential learning method versus a traditional method.

### **Procedures**

This study used a modified version of Campbell and Stanley's (1963) quasi-experimental counterbalance design for collecting data. The quasi-experimental design was chosen because subjects are required to complete multiple tasks and take multiple tests and were not able to be randomly assigned (Tuckman, 1999). Teachers, one male and one female, were selected because of their subject area expertise and their experience in using both traditional and experiential learning methodologies. Both teachers have more than ten years of experience teaching mathematics at this participating school and have worked cooperatively for several years.

The setting for this study was a private residential school, for at-risk children, in central Pennsylvania. All students come from a family with limited income and have at least average academic ability. The population consisted of all students (N= 95) enrolled in tenth grade geometry during the 1999-2000 school year. In order to ensure the groups were equal, participants were compared on gender, years at this school, and grade level. Performance of both groups was compared on accumulated grade point average (GPA), scores on a standardized mathematics performance test (CTPIII), and pretest scores based on information related to the units of study in this experiment.

Units of instruction were planned for surface area and volume and coordinate geometry. The project-based plans and the traditional classroom plans contained the same subject specific material to be covered. The first unit of instruction (surface area and volume) was taught in the traditional classroom method, using a page-by-page, explanation and practice approach to teaching. The project-based instructional approach to surface area and volume had students design, construct, and evaluate ice cream molds. The second unit of study (coordinate geometry) used a traditional classroom method similar to the one used for unit one. The project-based method directed students to design corn mazes using GPS (Global Positioning Satellite System) technology, to a designated degree of accuracy. A combination of classroom observations and audio taping were used to verify the levels of treatment for this study.

All students in the study were given a commercially produced geometry pretest (25 questions) two weeks prior to the first unit of instruction to establish a baseline level of performance for related subject matter. Immediately following a unit of instruction, all students were given a semantic-differential type of survey instrument to determine their attitude toward the instructional method. The attitude toward instructional method instrument was validated by a panel of five experts to determine its appropriateness for meeting the objectives of the study, readability, and for use with the intended age group. Reliability of this instrument was established with a Cronbach's Alpha of .86. Identical commercially produced unit tests for each unit of instruction in geometry were administered to all students following the attitude survey (20 questions for Unit I, 12 questions for Unit II). Two weeks after the completion of the last unit of

instruction, the pretest was again administered to all students as a test to determine the level of long term retention. A set of interview questions was used to gather qualitative information from individual interviews with each teacher at the end of the study.

### **Data Analysis**

The population for this study consisted of a census. Descriptive statistics were used to analyze the data collected. Means and frequencies were used to compare achievement data. The attitude toward instructional methodology data used means and standard deviations for comparisons. Range of scores, percentages and standard deviations comprised the techniques for analysis for the differences in retention of information between students participating in the different instructional methodologies. Content analysis of the interviews with teachers were used to analyze individual assessments of the methodologies.

### **Results**

Participants' Characteristics: The participants were divided into two predetermined groups (Group I, Group II) based on the teachers to whom they were assigned. The students' characteristics were assessed to determine group comparisons with regard to gender, years at this school, grade level, accumulated grade point average, scores on a standardized mathematics performance test, and pretest scores. Group I had a higher percentage of females (61.0%) than Group II (48.1%). The majority of both groups have attended this school for three years or less (Group I – 63.4%; Group II – 57.4%) and over 90% of both groups were in tenth grade.

Performance results prior to treatment show similarities between both groups of participants. The accumulated grade point means (Group I - 2.53, SD=0.71; Group II – 2.70, SD=0.60) suggest similar performance in all subjects prior to the study. The standardized mathematics test mean scores (Group I – 348.4, SD=23.6; Group II – 348.6, SD=23.6) indicate comparable levels of performance on a nationally referenced examination. The pretest mean scores also show a similarity among the groups (Group I – 5.13, SD=2.20; Group II – 4.85, SD=2.10).

The demographic and performance characteristics of the participants indicate that the students entered this study with similar backgrounds and similar levels of performance. This would suggest that all students, individually and in groups, entered this study with similar opportunities for success.

Objective 1 - Student Achievement and Retention: The data collected show a higher level of achievement on the unit tests immediately following instruction for those students who were taught through the traditional classroom method of instruction. Table 1 shows that both units of instruction produced similar comparisons.

Retention of knowledge suggests a slightly different outcome. When comparing the percentage of gain or loss between the posttest and unit test scores for each unit of instruction, one finds a higher percentage of retention for students who were taught through the project-based method. Unit one showed an increase between the unit test scores and the posttest scores.

However, the increase was much higher for the project-based group (31.5%) compared to the traditional group ((7.41%).

Table 1

Mean Achievement Scores for Surface Area and Volume (Unit One) and Coordinate Geometry (Unit Two) by Project-Based and Traditional Classroom Methods of Instruction.

Unit of Instruction Method of Instruction	F	Unit Test		F	Post Test		Mean Score	↑ ↓
		Mean	SD		Mean	SD	% Increase % Decrease	
Unit One								
Surface Area and Volume								
Project-based	40	5.63	2.45	36	8.22	2.73	31.5%	↑
Traditional	53	7.64	2.96	51	8.25	2.27	7.45%	↑
Unit Two								
Coordinate Geometry								
Project-based	53	2.26	2.00	51	1.71	1.66	24.3%	↓
Traditional	40	5.05	2.44	36	2.58	2.03	47.9%	↓

Unit two showed a decline in scores between the unit test and the posttest. The decline was much higher for the traditional group (48.9%) compared to the project-based group (24.3%). The first unit of study on surface area and volume used skills and knowledge that was more familiar to the students in this study because of past practice. The second unit of study on coordinate geometry was a more abstract concept and used skills and knowledge less familiar to the students in the study. One might suggest that this discrepancy in knowledge and skill base could account for the posttest scores being elevated for the more familiar subject matter and low for the less familiar material.

**Objective 2 - Attitude Toward Method of Instruction:** Table 2 shows student attitude toward learning was slightly more positive for the project group (M=18.53, SD=5.81) than for the traditional group (M=16.71, SD=4.90) for the same unit of study on surface area and volume. The reverse appeared in the second unit of study on coordinate geometry. The traditional group had a more positive value on their attitude toward learning (M=20.67, SD=5.30) than the project group (M=16.80, SD=5.26) for the same unit of study.

### Conclusions

The research suggests that educational experiences which are relevant and meaningful are the most effective pathways to learning. The data from this study supports the literature to the extent that when students are able to develop a connectedness through real-life experiences, they are able to apply that learning to other situations. The higher achievement scores, as indicated by the posttest results, for the traditional methodology students immediately following the unit of

instruction supports the research position of mastery of isolated skills and the development of knowledge to perform successfully on standardized tests (Buck Institute of Education, 1999). The greater percentage of knowledge retained, as indicated by the posttest results, by those students in the project-based experiential learning method supports the research of Dewey,(1933) Piaget (Jacob, 1984), Gardner (1999), Caine and Caine (1991), Hart (1983), and others and indicates that these students demonstrated the ability to use their experiences successfully over time.

Table 2

Group Mean Scores for Attitude Toward Learning

Unit of Study and Score by Method	f	M	SD
Surface Area and Volume			
Project	40	18.53	5.81
Traditional	52	16.71	4.90
Coordinate Geometry			
Project	51	16.80	5.26
Traditional	39	20.67	5.30

Note. Scores on the attitude instrument had a possible score range of 6 (most negative) to 30 (most positive). The theoretical midpoint was 18.

The data from the study do not indicate an advantage or disadvantage for either method of instruction as it relates to students' attitude toward the methods of instruction. The data suggest that those students who were first involved in the project-based experiential method of instruction had a more positive attitude toward the method of instruction than those students in the traditional method of instruction. However, this same group with the higher attitude toward method of instruction scores for the first unit of instruction also had higher scores toward the traditional method of instruction for the second unit of instruction. This would suggest that further research is warranted to determine the identity and control extraneous variables, such as the characteristics of the instructors and their familiarity with the projects, that may have influenced the results.

**Implications**

The role of the teacher is complex and continually changes. This study suggests that both the project-based and traditional classroom method of instruction show strengths that can be utilized for student achievement. The ability of teachers to coordinate the use of these methods of instruction to bring about the most positive educational results along with the most effective and efficient use of time holds an increasingly important place in the future success of the educational community. This implies: (1) a need to restructure the scheduling and curricular frameworks of the learning environment, (2) a staff development program preparing for broader

interdisciplinary interactions, (3) a different approach to assessment, and (4) looking at agricultural education in terms of both an interdisciplinary conduit through which learning takes place along with its established role as a key career and technical opportunity.

Two innovations in the structuring of the school day, block scheduling and intensive scheduling, continue to be implemented in schools across the country. The focused blocks of class time and/or the concentration of classes in a semester would suggest an opportunity to combine the project-based and experiential and traditional methods of instruction for both improved instruction and student achievement. The results of this study would imply a greater chance for student success by taking advantage of teaching strategies that would address both the needs of the students for short term recall while building connections that increase their ability to retain and transfer their skills and knowledge. This combination builds on existing research that supports the mastery of isolated skills to develop knowledge that enables short-term performance (Buck Institute of Education, 1999) and the building of connectedness through real-life experiences (Caine and Caine, 1991; Hart, 1983; Dewey, 1933; Gardner, 1999).

Research has shown that the integration of science into the agricultural curricula can be a more effective way of teaching science (Balschweid, Thompson, and Cole, 1998). This study implies that the same opportunity for success may apply to other disciplines as well. However, this study suggests that the use of agricultural projects alone may not be as effective an instructional strategy as combining the more traditional strategies, where appropriate, with the project-based experiential component. The ability to experience and explore the application of this knowledge and skills provides valuable connections between what is known, what is learned, and why it is important.

Society is constantly in search of a magic, one size-fits-all solution. The complexity of individuals and environments does not allow for these types of solutions in very many situations. The educational community must continue to evaluate and search-out new and renewed solutions for success. This study indicates a positive value in the research that has preceded it and the hope for the application that lies ahead.

### **Recommendations**

The limiting parameters of this study dictated that a quasi-experimental design be utilized. The study was also isolated to one institution and with a relatively small population. Therefore it is recommended that further study be done in related areas to compare the efficacy of the project-based experiential learning and traditional methods of instruction on:

1. the effect of gender as it relates to achievement using these two methodologies,
2. the effect of the students' learning styles on achievement as related to the two methodologies, and
3. the effect on achievement of these two methods of instruction when comparing agriculture and a variety of academic disciplines, i.e. language

arts, social studies, visual and performing arts, etc.

This study also suggests that both of the instructional methodologies used have advantages. It is recommended that further research into the advantages inherent in combining of these methods of instruction and the planning strategies that enhance a variety of educational needs and situations. Since this study only utilized a population of tenth grade students it is recommended that the aforementioned study include multiple levels of the K-12 educational experience.

This study did not indicate an advantage or disadvantage of either instructional methodology on the students' attitudes toward the method of instruction. The attitude toward instruction may reflect the overall composition of the group and/or the influence of the instructor. Further research is needed to investigate the degree to which the characteristics of the instructional group and the instructor influence the attitude toward instruction when involved in the project-based experiential and traditional methods of instruction.

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