

# Problem based learning pbl



## **Introduction**

Problem-based learning (PBL) is a pedagogical tool in which students engage in a problem without introductory knowledge; they work to solve the problem by using existing knowledge and applying it to the situation in order to reach a solution (Wirkala & Kuhn, 2011). The National Council of Teachers of Mathematics describes technology as an essential element in teaching and learning mathematics (NCTM, 2000). The use of computers “ influences the mathematics that is taught and enhances students’ learning” (2000). When implemented effectively, technology can be a tremendous tool for learning. “ Computers can be used...as an environment for exploring mathematical concepts through interaction” (Huetinck & Munshin, 2008, p. 87). In this study, students will explore mathematical concepts using computers via a problem-based learning approach. Specifically, this research study will investigate how computer-assisted PBL effects student interest and achievement in a high school mathematics course. Much research has been done to investigate PBL in medicine and science. There has been more research in mathematics education that investigates the effects of PBL on achievement than of PBL and interest. I would like to examine both of these factors. The question of interest is as follows: How do using computers to teach problem-based learning (PBL) in high school mathematics classrooms increase student interest and achievement in mathematics?

Following the introduction, in section 2, relevant literature about PBL will be discussed. In section 3, the statistical methods will be stated. In section 4, the analysis of the data will be presented. In section 5, my conclusion and discussion will be given.

## Literature Review

### PBL in Medicine

Various researchers in the medical field have studied problem-based learning for quite some time. In the 1980s and 1990s, PBL was used in medical schools and began to be accepted by schools in North America and Europe (Savery, 2006). Researchers have studied how PBL effects achievement and/or knowledge. One group of researchers studied academic achievement of students in two medical schools (Verhoeven, Verwijnen, Scherpbier, Holdrinet, Oeseburg, Bulte, & Van Der Vleuten, 1998). One school had a PBL instructional design and the other used a non-PBL instructional design. Test results showed no significant differences on total test scores. “ After the test was split into three categories, a few, non-systematic differences were found” (p. 310). Hmelo (1999) studied how PBL in medical education can affect cognitive skill. The study found that “ the PBL students increased the accuracy of their hypotheses more than the nonPBL students” (p. 197). The conclusion of the findings show that using a PBL approach in medical education does make a difference in what students learn. Another study examined “ students’ performances on Step 1 and Step 2 of the United States Medical Licensing Examination(USMLE) following the implementation of a problem-based learning curriculum” (Blake, Hosokawa, & Riley, 2000, p. 66). This study analyzed scores and found that students in the PBL classes scored higher on USMLE Step 1 than did students in the traditional classes. For the USMLE Step 2, the average test score for students in the PBL classes were above the national mean. In contrast, score were “ below the national mean for classes in the traditional curriculum” (p. 66).

Based on the data, the study concluded that “ the use of a PBL curriculum as a major educational method during the first two years of medical school does not compromise performance on standardized tests” (p. 69). Other researchers found that in a PBL program; there were “ significant knowledge gain” (Schwartz, Donnelly, Sloan, Young, 1994, p. 148). Knowledge gain was measured by giving students a pre and posttest. “ Students were administered an NBME surgery shelf examination on the first day of the clerkship (pretest) and a different one of the last day (posttest)” (p. 148). Another study compared clinical performances in a medical clerkship of students who were enrolled in a class that used a PBL approach versus students who were enrolled in a class that used a traditional style approach (Richards, Ober, Cariaga-Lo, Camp, Philp, McFarlane, Rupps, & Zaccaro, 1996). The PBL participants consisted of 88 third year internal medicine students. The lecture-based learning (LBL) participants consisted of 364 students in the same program. The researchers compared examination scores between the two groups. The results reveal that the students who had completed two years in the PBL curriculum had a “ higher medicine clerkship rating” (p. 189). Thus, this study determined that a PBL curriculum “ may enhance...clinical performances” (p. 187). A similar study was performed in a postgraduate medical education program in The Netherlands. The study aimed to examine “ the effectiveness of problem-based learning in comparison with lecture-based learning” (Smits, de Buissonje, Verbeek, Dijk, Metz, & Cate, 2003, p. 280). Knowledge, in terms of achievement, was measured by tests. They found that under PBL instruction, performance increased more. In the conclusion, the researchers state that “ this study

shows evidence that the problem-based program has some small extra value for the participants in improving their performance” (p. 285).

Although there is a limited amount of research on the impacts of PBL on interest, there have been a few researchers to study this situation. Biley (1999) studied PBL in a nursing program. The study found that there were both advantages and disadvantages of using PBL in instruction. A disadvantage the study found is that “ tension occurred during the process of changing from more traditional forms of education to PBL” (p. 587). The findings also showed benefits of PBL which coincide with previous studies; the benefits include “ the recognition of increased self-motivation, team work, and a more accurate theoretical representation in the classroom” (p. 588). Smits, et. al (2003) studied student’s satisfaction in addition to knowledge. Satisfaction was measured by a rating. Researchers found that “ the problem-based group was significantly less satisfied than the lecture-based group” (p. 284). Another study found dissimilar data relating to interest and enjoyment. Sobral (1995) found that PBL students had a “ higher level of enjoyment” and reported that they “ enjoyed their learning experience and would be more likely to look for studies in the same field” (99). The researchers concluded that “ the PBL approach can improve the quality of the learning environment in both cognitive and emotional ways” (p. 93).

### PBL in Science Education

Researchers in science education have also studied the impacts of problem-based learning on achievement. One study (Gürses, Açıkyıldız,

DoÄŸar, & Sözbilir, 2007) examined the impact of PBL in a physical chemistry laboratory class. Researchers looked at “ students’ attitudes towards a chemistry laboratory course, scientific process skills of students, and their academic achievement” in relation to PBL (p. 99). They found that after students were exposed to PBL, their test scores were considerably higher. A similar study was done in a chemistry class. Tarhan and Acar (2007) examined how effective PBL is in increasing student achievement. “ Results from the post-test...showed that PBL is effective on students’ achievement” (Tarhan, & Acar, 2007, p. 351). One group of researchers investigated the effects of PBL for female students enrolled in a STEM program (Lou, Diez, & Tseng, 2011). They found that “ students tended to gain more solid science and mathematics knowledge through STEM learning in PBL” (Lou, Diez, & Tseng, 2011, p. 195). Another study investigated PBL in science by conducting research using an experimental (PBL group) and control group (textbook group) (Inel & Balim, 2010). Researchers examined how PBL affected academic achievement; they found a significant difference between the groups. Specifically, researchers concluded the “ problem-based learning method in science...teaching is more effective in enhancing students’ academic achievement than simply using the science...curriculum” (Inel & Balim, 2010, p. 16). Similarly, Sungur, Tekkaya, and Geban (2006) conducted a study to examine the effect of PBL on academic achievement and performance in a biology class. Participants were randomly assigned to one of two groups: the control or experimental group. Students were given a pre- and post-test that measured academic achievement and performance. Researchers concluded that “ PBI instruction caused a significantly better acquisition of scientific conceptions than the traditional instruction” (Sungur, <https://assignbuster.com/problem-based-learning-pbl/>

Tekkaya, & Geban, 2006, p. 158). AkinoÄlue and TandoÄan (2007) investigated PBL in science education. They gathered research to determine how PBL effects achievement, attitude, and concept learning. Researchers concluded “ that the implementation of problem-based active learning model had positively affected students’ academic achievement... [in] the science course” (AkinoÄlue & TandoÄan, 2007, p. 71). Chang (2001) conducted research in several 10th grade science classes to study how “ problem-based computer-assisted instruction (PBCAI)” impacts science achievement (p. 147). The researcher compared the PBCAI to a “ direct-interactive teaching method (DITM)” (p. 147). He determined that more students in the PBCAI group had higher scores than the DITM group in terms of achievement. Chang concluded, “ the PBCAI was more effective in promoting students’ achievement than was the DITM” (p. 147). Liu, Hsieh, Cho, and Schallert (2006) studied self-efficacy, attitudes, and achievement in a computer-enhanced PBL class. This study is similar to the research of the present study. The participants of interest in this study were middle school students. Researchers collected data from 549 sixth graders from two middle schools. Data was collected from a pretest/posttest, questionnaire, and interviews. Data “ indicated an increase in students’ science achievement and self-efficacy for learning science after their engagement in a computer-enhanced PBL environment” (Liu, Hsieh, Cho, & Schallert, 2006, p. 225).

Researchers in science education have also studied the impacts of problem-based learning on student interest in and attitude of science. Grses, AÄkyÄldÄz, DoÄar, and Szbilir (2007) collected data from a physical chemistry lab regarding students’ attitudes towards the class through a PBL

treatment. They found “ student’s attitudes towards...the course were not changed significantly after PBL treatment” (p. 109). Liu, Hsieh, Cho, and Schallert (2006) found an increase in science achievement in a computer-enhanced PBL class. They also collected data about students’ attitudes towards science. Based on their findings, they found no significant change. Besides studying achievement in a PBL class, Tarhan and Acar (2007), also conducted student interviews and found that students enrolled in the PBL class were “ more motivated” (p. 351). Motivation relates to attitude in and interest of science. Another study, by Ferreira and Trudel (2012), investigated how a PBL curriculum in science impacts student attitudes toward science. Participants answered survey questions, wrote in student journals, and took an assessment. Data was gathered from these instruments in addition to teacher observations (Ferreira & Trudel, 2012). Researchers found that there was “ a significant increase in student attitudes towards science” (Ferreira & Trudel, 2012, p. 23). Lou, Diez, and Tsend (2011), who studied the effects of PBL for female students enrolled in a STEM program collected data related to student attitudes (Lou, Diez, & Tseng, 2011). Researchers found that the participants from the PBL curriculum attitude towards STEM improved. Akino and Tando (2007) investigated the effects of PBL in science education. They collected data to determine how PBL effects students’ attitude towards science. Researchers concluded “ that the implementation of problem-based active learning model had positively affected students’...attitudes towards the science course” (Akino & Tando, 2007, p. 71). Nancy Cerezo (2004) examined PBL in middle school math and science classes. The study investigated student’s



perceptions of PBL in regards to its' effectiveness and students' interest in the content.

Results from the study indicated that students perceived problem-based learning encouraged their interest and provided a more in-depth understanding of the concepts. Students indicated that problem-based learning helped them learn more about a topic and created a feeling of excitement about coming to class. (Cerezo, 2004, p. 9)

This study related to the present study since it investigated PBL in mathematics and how students' interest in mathematics changes.

All research pointed to increased achievement or improved knowledge when a PBL curriculum was implemented in a science classroom. Gürses, Açıkyıldız, Doğan, and Sözbilir; Liu, Hsieh, Cho, and Schallert; provided conclusions that were contradictory to the findings of Tarhan and Acar; Akinoğlu and Tandoğan; Lou, Diez, and Tseng; Ferreira and Trudel; and Cerezo in regards to interest in the subject or motivation. Specifically, the latter being the researchers who saw a significant difference in interest towards the subject. That is, that they found that there is a relationship between PBL and increased interest in a subject.

#### PBL in Mathematics Education

In mathematics education, PBL is relatively new, but many researchers have found that it is effective in increasing achievement. One team of researchers found no statistically significant data in favor of PBL (Tarmizi, Tarmizi, Lojinin, & Mokhtar, 2010). Researchers conducted a study “ to investigate

the effects of PBL on mathematical performance, measure of instructional efficiency, and perceived advantages or disadvantages of the approach” (Tarmizi, Tarmizi, Lojinin, & Mokhtar, 2010, p. 4683). They used a quasi-experimental design and gathered data via a posttest. Each variable of interest of the study was measured using a specific tool. First, scores from tests measured “ mathematics performance”(p. 4685). Next, researchers collected data for “ mental effort” via a “ nine-point symmetrical category scale” (p. 4685). “ Efficiency index is a term which shows the relationship between learning and test (mental) effort and performance” (p. 4685). Researchers used a mathematical formula to calculate data for this variable. Last, “ affective attributes” were measured using Likert-style questions. Researchers found that the average scores for the overall achievement for the PBL group were greater than the control group. After researchers statistical analyzed the data, they determined that “ the mean difference was not statistically significant” (p. 2685). Another group of researchers, Clarke, Breed, and Fraser (2004), studied participants at three high schools in California. Researchers investigated how a “ problem-based mathematics curriculum, the Interactive Mathematics Program (IMP)” were related to student achievement (p. 8). Researchers also collected data to measure achievement or mathematical performance. They compared PBL/IMP students to their peers in conventional classes. This data came in the form of test scores from the Scholastic Aptitude Test (SAT). Findings show that “ IMP students averaged higher SAT scores than did pupils of conventional classes” (p. 14). PBL was studied in another area of mathematics, Statistics (Tarmizi & Bayat, 2011). Researchers compared data between a PBL group and a conventional group. Two posttests were administered and the scores were

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analyzed. They concluded “ that there was a significant difference between the mean performance of the PBL group and that of the conventional group – indicating PBL efficacy” (p. 344). Bostic and Jacobbe (2010) studied PBL in a fifth grade mathematics classroom. Researchers collected data by administering a pre-test, posttest, and student interviews. Data from the pre-test and posttest showed statistically significant growth in students’ ability to solve problems correctly (Bostic & Jacobbe, 2010).

Similarly, there has been some research to investigate the relationship between PBL and interest in mathematics. An indication that students are interested in mathematics is the students’ level of engagement. Tarmizi, Tarmizi, Lojinin, and Mokhtar (2010) also studied the effect of PBL and student engagement. Student engagement was measured by an open-ended survey. “ The mean average rubric engagement score was a 2. 08, which indicated that the PBL group had benefited from the learning experiences with a proficient level” (Tarmizi et al., 2010, p. 4687). Another research team studied the relationship of PBL in mathematics and student perceptions of mathematics (Clarke, Breed, & Fraser, 2004). A “ problem-based mathematics curriculum, the Interactive Mathematics Program (IMP)”, was implemented in three California high schools (p. 7). Researchers collected data from two questionnaires. “ The Mathematics Belief questionnaire examined student perceptions of their mathematical competence, and student beliefs about mathematical activity and the origins of mathematical ideas” (p. 9). “ The Mathematics World questionnaire required students to identify the extent to which specific everyday activities were mathematical” (p. 9). In comparison to traditional Algebra classes, researchers found that “

IMP students help a significantly more positive attitude towards mathematics” (p. 14). The IMP participants also felt “ more mathematically able” than their peers (p. 14).

### Use of computers in mathematics

In mathematics, using computers and other related technologies to enhance instruction can greatly affect student achievement. “ Computers can be used...as an environment for exploring mathematical concepts through interaction” (Huetinck & Munshin, 2008, p. 87). When students are actively interacting with new ideas, their level of engagement and knowledge increases. “ Computers enable students to quickly explore many varied examples to generalize about the underlying characteristics of mathematical entities” (p. 89). If students can make more generalizations, they will be more likely to be able to apply the concepts later. One group of researchers investigated how implementing a dynamical geometric software such as Geometer’s Sketchpad (GSP) affects mathematics teaching (Nordin, Zaharia, Mohamed, Embi, 2010). They found that this “ exploratory learning method and the discussions involved in understanding the mathematical concepts adopted from the gsp digital module can help boost higher order thinking skills” (Nordin, Zaharia, Mohamed, Embi, 2010, p. 116). O’Callaghan (1998) found that a computer program implemented in Algebra had greater achievement than their peers did in traditional algebra classes. Palmiter (1991) conducted research with university students and compared achievement between students enrolled in a class taught using a computer algebra system and students enrolled in a class taught using paper-and-pencil computations (1991). The researcher found that students enrolled in <https://assignbuster.com/problem-based-learning-pbl/>

the class that was taught with the computer system had higher test scores for both the conceptual and computational exam (1991). Ragasa (2008) investigated the effects of computer-assisted instruction on achievement of college students in a statistics course. The researcher found that “ the mean score of the posttest of the achievement test” for the computer-assisted group was “ significantly higher than that of the control group” (Ragasa, 2008).

In mathematics, the use of computers to aid instruction can improve students attitude and interest in mathematics. Ragasa (2008) also studied students’ attitudes in response to computer-assisted instruction. The researcher was unable to conclude that there was a significant effect on student attitude. O’Callaghan (1998) studied the effects of “ Computer-Intensive Algebra (CIA) and traditional algebra curricula on students’ understanding of the function concept” (p. 21). Among other findings, O’Callaghan discovered that the CIA students’ attitudes were significantly different higher (1998). Another study examined college students’ attitudes towards using computers as an instructional aid in an Algebra class (Ganguli, 1992). The researcher determined that the attitudes of the students in the computer group were significantly increased.

I hypothesize that in high school mathematics, problem-based learning, through the use of computers, will increase student interest and achievement. Previous studies have demonstrated similar findings. In the following section, methods will be discussed.