Journal Homepage: -www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)

Article DOI:10.21474/IJAR01/20747
DOI URL: http://dx.doi.org/10.21474/IJAR01/20747

RESEARCH ARTICLE

INVESTIGATING THE IMPACT OF PROBLEM - BASED LEARNING ON STUDENTS ATTITUDES TOWARD MATHEMATICS

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Manuscript Info

Manuscript History
Received: 15 Febuary 2025
Final Accepted: 18 March 2025
Published: April 2025

Keywords:
Problem Based Learning (PBL), Interest, Perception, Anxiety, Self- Efficacy

Abstract

Student success in a variety of disciplines depends on their ability to analyze and solve problems, which is something that mathematics education plays a critical role in developing. Unfortunately, a lot of students have a bad attitude toward mathematics and think it's a difficult and boring topic. They may do less academically and be less inclined to interact with mathematical ideas as a result of this unfavorable opinion(Belland & etal, 2006). It is vital to identify efficient teaching strategies that can change students' perceptions about mathematics.A promising educational strategy that places an emphasis on student-centered learning and practical problem-solving is called problem-based learning, or PBL. PBL promotes critical thinking, teamwork, and active engagement in contrast to traditional teaching approaches, which frequently focus on rote memorization and passive learning(Lester, 2013). PBL attempts to make learning more relevant and interesting by giving students challenging, real-world problems to answer. This might change students' perspectives on mathematics.Unde rstanding how PBL influences students' attitudes towards mathematics is essential for educators and policymakers seeking to improve mathematics education practices. By exploring this impact, educators can gain insights into effective strategies for promoting positive attitudes and enhancing student learning experiences in mathematics.Re search has demonstrated that PBL can improve students' attitudes about many subjects by making learning more engaging and pleasurable (Hung, Jonassen, & Liu, 2008). In mathematics education, PBL has been linked to enhanced student motivation, better problem-solving abilities, and more self-efficacy(Walker & Leary, 2009).

Introduction

Student success in a variety of disciplines depends on their ability to analyze and solve problems, which is something that mathematics education plays a critical role in developing. Unfortunately, a lot of students have a bad attitude toward mathematics and think it's a difficult and boring topic. They may do less academically and be less inclined to interact with mathematical ideas as a result of this unfavorable opinion(Belland & etal, 2006). It is vital to identify efficient teaching strategies that can change students' perceptions about mathematics.

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A promising educational strategy that places an emphasis on student-centered learning and practical problem-solving is called problem-based learning, or PBL. PBL promotes critical thinking, teamwork, and active engagement in contrast to traditional teaching approaches, which frequently focus on rote memorization and passive learning(Lester, 2013). PBL attempts to make learning more relevant and interesting by giving students challenging, real-world problems to answer. This might change students' perspectives on mathematics.Understanding how PBL influences students' attitudes towards mathematics is essential for educators and policymakers seeking to improve mathematics education practices. By exploring this impact, educators can gain insights into effective strategies for promoting positive attitudes and enhancing student learning experiences in mathematics.Research has demonstrated that PBL can improve students' attitudes about many subjects by making learning more engaging and pleasurable (Hung, Jonassen, & Liu, 2008). In mathematics education, PBL has been linked to enhanced student motivation, better problem-solving abilities, and more self-efficacy(Walker & Leary, 2009).

An empirical study that particularly looks at how Problem-Based Learning (PBL) influences students' attitudes toward mathematics is limited, though PBL is becoming more and more popular in mathematics education. The essence of this study is to investigate how students' attitudes about mathematics are affected by Problem-Based Learning (PBL). This research aims to bridge the gap in the current literature by investigating how PBL affects students' perceptions of mathematics, including their interest, anxiety, and self-efficacy. This will provide important insights into the potential advantages of PBL in improving students' attitudes towards mathematics.

Research Objectives.

1. To find out the effect of PBL on students' interest in mathematics
2. To examine the effect of PBL on students' self- efficacy in mathematics.
3. To determine effect of PBL on students' perception of mathematics
4. To investigate the effect of PBL on students' anxiety in mathematics

Hypothesis

H_1: PBL instruction has no significant effect on students' interest in mathematics.
H_2: PBL instruction does not significantly increase student's self-efficacy in mathematics.
H_3: PBL instruction has no positive perception of students on mathematics.
H_4: PBL instruction has no significant effect on students' anxiety towards mathematics.

Literature Review

Theoretical review

Constructivist Learning Theory, primarily associated with the work of (Piaget, 1972)and (Vygotsky, 1978), posits that learners construct knowledge through experiences and interactions with their environment. PBL is inherently constructivist as it involves students actively engaging in problem-solving, which allows them to construct and internalize mathematical concepts. According to constructivist theory, learning is most effective when students are actively involved in a process of meaning and knowledge construction as opposed to passively receiving information.

Empirical review

Ogunsola, et al (2021) believes that conventional teaching method is one of the factors contributing to poor performance in mathematics, one of the modern methods of teaching which is fast gaining relevance due to its ability to instill problem -solving skills in student is Problem base learning. They examined the effect of the problem-based learning (PBL) approach on students' academic performance in senior secondary Mathematics. Quasi-experimental design was adopted in the study and pre-test and post- test was the means for data collection for analysis. Analysis of covariance was the inferential statistics employed in the analysis of the data. The study revealed that problem-based learning approach enhanced students' academic performance in Mathematics (F1, 108= 7.130; p = (.009) < .05). Theis means PBL is practically effective for teaching and learning of mathematics. They also found out that academic performance of students is independent of gender (F1, 108= .051; p = (.821) > .05). In addition, there was no significant interaction effect of PBL and gender on students' academic performance in Mathematics (F1, 108= .000; p = (.985) > .05). Again, their study realizes that there is a significant main effect of PBL on the quantitative ability of students (F1, 108= 6.756; p = (.010) < .05). They concluded that employing PBL in teaching and learning of mathematics enhance students' mastery of mathematical concept, promotes knowledge construction and critical thinking, improves problem solving skills and their quantitative abilities and hence improving students' mathematics performance. It was recommended that stakeholders in education and the

government should train and retrain teachers on utilization of the PBL approach in Mathematics classrooms to enhance students' academic performance.

Abate etal (2022) assert that, attitudes towards mathematics learning are critical for understanding of a concept. The aim of their study was to investigate the effect of instructional approaches, Visualization Technique (VT), Problem-Base Learning Approach (PBLA), Visualization assisted Problem- based learning Approach (VT-PBLA) and Conventional instructional approach (CIA) on students' attitudes towards mathematics. Four attitudes' scales were employed, and these were; Confidence, usefulness, enjoyment and engagement. Quasi -experimental design was used as the research design. Four schools in Addis Ababa that has grade 7 and 8 were selected using purposive sampling. Four sections, one from each school were selected through simple random sampling technique. Three out of the four intact groups were set as intervention group1 (IG1), IG2 and IG3 where each of these three groups received a specific instructional approach, thus VT, PBLA and VT-PBLA. Paired samples t-test and ANCOVA were employed for analysis, and the results of the study show that the group taught with VT shown statistically significant difference on attitude and on each of the components of attitude, except for engagement. Also, the group taught with VT-PBLA also revealed a statistically significant difference on attitude and their components except for engagement and confidence. PBLA alone did not show any significant mean difference in students' attitude towards learning mathematics and each of the components. The post-intervention comparison also showed significant mean difference between the groups for the overall attitude and the components of attitude except for engagement and confidence. The Study concluded that VT and VT-PBLA were found to enhance students' attitude (Confidence, Usefulness, and enjoyment), hence it is important to utilize VT and VT-PBLA in teaching and learning of mathematics which in turn improve students' performance. But PBLA did not show any significance in students' attitude towards mathematics learning. However, all the instructional approaches did not have significant influence on engagement.

A study on the topic "The Effect of Using Project Based Learning on Improving the Critical Thinking among Upper Basic Students from Teachers' Perspective" by Issa and Khataibeh (2021) aimed at investigating the impact of a teaching strategy adopting project-based learning on improving the critical thinking among upper basic Stage Students from male and female Science teachers' perspectives. The study was guided by the question : Do teachers' perspectives differ regarding the acquisition of critical thinking by the upper basic stage students at the Al -Kourah District, Irbid City , Jordan, according to the teaching strategy (Project-based learning, Conventional Method)? Descriptive-analytical method, through a questionnaire which applied to (111) male and female Science teachers teaching upper basic schools in Al-Kourah District, Irbid, Jordan. The descriptive-analytical method was followed, one independent variable is teaching strategy, and it has two levels: project-based learning (PBL) and conventional method. The result shows that, there is a significant statistical difference (a= 0.05) attributed between the conventional method and the project-based learning strategy. Thus, PBL model influences students critical thinking in science positively as compared the conventional method. It was recommended that teaching and content of text books should be organized in line with the project-based teaching and learning strategy.

Azila et al (2022) looked at "Improving Critical Thinking Skills in Teaching through Problem-Based Learning for Students: A Scoping Review" and the objective of this study has been to produce an extensive mapping of themes related to problem-solving education and critical thinking skills in social sciences for the reference of future research. The Web of Science, Scopus, and ProQuest databases have been used to source published scientific literature on this topic and develop themes of critical thinking abilities in teaching through PBL for students. This scoping review applied the five-stage process which was outlined by Arksey and O'Malley (2005) and later expanded by Levac et al. (2010) to: (1) identify research questions; (2) identify relevant studies; (3) remove redundant articles; (4) chart the data; and (5) collate, summarize, and report the results. Only 20 publications were selected after a thorough selection process based on the Preferred Reporting Items for Systematic Review, which is known as PRISMA, adapted by Moher et al. (2015). The study concluded that, PBL approach has helped in the creation of soft skills such as critical thinking, problem-solving, self-directed learning, the ability to adapt, communication skills, interpersonal skills, and teamwork skills. Again, the examination of the data revealed that the PBL method in education enhances students team involvement and learning capacity, provides opportunities to practice skills, educates professionals with a holistic vision and improves critical thinking.

Assessing the attitude and problem-based learning in mathematics through PLS-SEM modeling by Zamir et al 92022). This study aimed to determine students' attitudes and achievements through problem-based learning in mathematics. Purposive sampling. The study population comprised 3,300 secondary mathematics students and 35 mathematics teachers in District Rawalpindi's 35 rural public secondary schools. The population is the mathematics students and teachers in North Punjab District Rawalpindi Government Areas as of the 2020/2021 academic session. A structured questionnaire with a Likert scale was used to investigate the mathematics attitudes toward students. Descriptive statistics, hypothesis testing is used for analysis. Analysis was performed by examining the correlations,

covariance patterns between the observed measures and hypotheses testing were used for this study. According to the regression weight, in the students' model, the high weight record in C11 (In terms of my adult life it is not important for me to do well in mathematics in high school.) and it recorded 0.664, V10 (Taking mathematics is a waste of time.). It recorded 1.01, AE7 (Winning a prize in mathematics would make me feel unpleasantly conspicuous) and it recorded 0.88, M8 (The challenge of math problems does not appeal to me), and it recorded 0.90.

The PLS-SEM result shows that students' model show a negative attitude towards mathematics. The teachers'PLS-SEM model showed the Effects of using problem-based learning (PBL) on students'achievements. Again, Confidence in Learning Mathematics Scale (C), Value of Mathematics Scale(V), and Student Mathematics Motivation Scale (M) had significant effects on Students'Attitude Toward Problem-Based Learning (ATPBL). Attitude Toward Enjoyment inMathematics Scale (AE) did not significantly affect the ATPBL. The analysis of the result also revealed that, Problem-solving learning and students' achievement (PLA), Advantages of problem-solvinglearning (APL) and Difficulties in using problem-solving learning (DPL) have a significantpositive effect on the ATPBL.

Investigate the impact of PBL on students' interest in mathematics.

PBL has been demonstrated in studies to boost students' interest in mathematics.Students who engaged in PBL had a much higher interest in mathematics than those who got conventional education, according to 2004 research by (Hmelo-Silver, 2004). PBL enhanced students' enthusiasm in mathematics and resulted in a deeper understanding of the topic, according to(Walker & Leary, 2009).Improving elementary school students' mathematics literacy through problem-based learning and practical instruction. He found that the interplay between the model problem-based learning and the direct instruction models had a significant impact on the development of mathematical literacy in elementary school students.

Examine the effect of PBL on students' self-efficacy in mathematics.

Studies have indicated that PBL can raise students' mathematical self-efficacy. Students that are engaged in PBL had a considerable boost in their self-efficacy in mathematics when compared to those who got standard education, according to research by (Bandura, 1997). (Schunk, 2003)discovered that problem-solving confidence and self-efficacy in mathematics were enhanced by PBL for pupils.

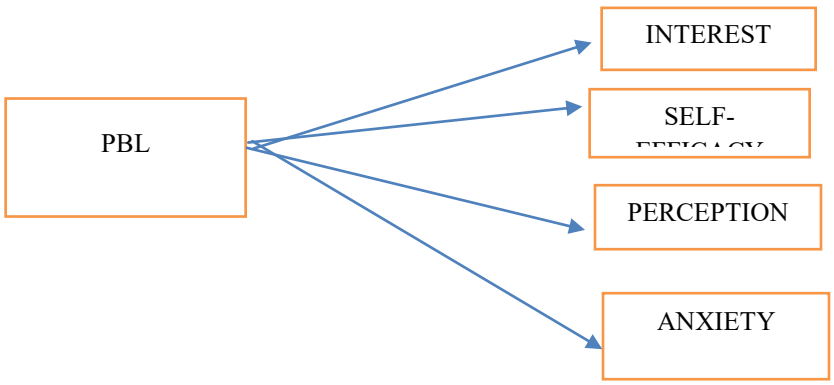
Determine whether PBL influences students' perceptions of mathematics

According to studies, PBL can have a favorable impact on how children view mathematics.According to (Lester, 2013)study, students who engaged in PBL had more favorable opinions of mathematics and believed it to be more relevant and helpful.Accordingto(Rasmussen, 2014)findings, PBL helped pupils appreciate and love mathematics more.

Explore whether PBL affects students' anxiety level to mathematics

Studies have indicated that problem-based learning (PBL) can help students feel less anxious when it comes to math. (Hembree, 1991) study found that students who engaged in PBL had significantly lower math anxiety than those who received traditional instruction. (Newman, 2012)also found that PBL helped students feel less anxious about math and increased confidence in their problem-solving skills.

Conceptual framework



Methodology

This study is based on the positivist paradigm. It adopted quantitative study with a descriptive design. The population for the study is the students of two Senior High Schools in Kumasi, Ashanti region of Ghana, specifically form two students with a sample size of 30 using a stratified sampling to separate students into two different strata that is student who has been taught with and without problem- based learning and simple randomtechnique to select from each stratum. Data collection instrument used in the study is the 5 points Likert scale structured questionnaire with 30 items in all.The questionnaire consists of five sections labeled A- E. Section A comprises the background information (Gender, Age and level of the student). Section B contains statements on students' interest in mathematics in relation to problem -based learning with eight different items ranging from strongly agreed to strongly disagreed.SectionC also contains eight statements on students' self- efficacy in mathematics in relation to PBL ranging from strongly agreed to strongly disagreed. Section D contains five statements on student perception of mathematics in relation to PBL ranging from strongly agreed to strongly disagreed. Section E also consists of eight statements on students' anxiety toward mathematics ranging from strongly agreed to strongly disagreed. The questionnaires were administered face to face to the students. The concert of the students was asked. The purpose of the survey was discussed with students, the confidentiality of their responses was also assured and the procedures to answering the questions were also discussed properly.

Data Analysis

The main data analysis tool used in this study is the one- way multivariate analysis (MANOVA) where there was one independent variable Problem Based Learning(PBL),(approach to teaching) with two grouping (taught with and without PBL) and four dependent variables on attitudes towards mathematics(interest, self- efficacy, perception and anxiety)

The responses collected from the questionnaire was coded into SPSS version 23 (strongly agree = 5, agree = 4, neutral = 3, disagree = 2, and strongly disagreed = 1). The coded responses were again transformed into a continuous data using the statistical mean. The various assumptions underlying multivariate analysis was done using the SPSS

Table 1: Descriptive Statistics

	TAUGHT WITH PBL n=15		TAUGHT WITHOUT PBL n=15	
VARIABLES	MEAN	STANDARD DEVIATION	MEAN	STANDARD DEVIATION
INTEREST	4.1750	.45267	4.1750	.36535
PERCEPTION	4.1778	.52124	3.1556	.56508
SELF- EFFICACY	3.9083	.48749	3.5500	.30546
ANXIETY	3.8833	.42381	4.1750	.47198

Source: Field survey(2024)

Table 1 presents the descriptive statistics for students taught with and without the Problem-Based Learning (PBL) approach across four dependent variables: Interest, Perception, Self-Efficacy, and Anxiety. The result shows that those taught with PBL has a bigger mean score for perception and self-efficacy than those taught without PBL.

Result of Manova

A one-way MANOVA was used to investigate the impact of problem-based learning on students' attitudes toward mathematics achievement, as well as the difference between two groups (students taught with and without PBL). There were four dependent variables: student interest in mathematics, student self-efficacy, student perception, and anxiety. Normality, outliers, linearity, variance-covariance matrices homogeneity, and multicollinearity were assessed using preliminary assumption testing. The boxplot analysis revealed no univariate outliers. All Mahalanobi distances were less than the threshold value of 9.488, indicating that there were no multivariate outliers. This is a reasonable assumption. Shapiro-Wilk tests for both groups of the independent variable for all four dependent variables revealed that the normality assumption was met with a p-value larger than 0.05. The assumption of

linearity was satisfactory based on the scatterplot. The Box's test M value of 15.550 was associated with a p-value of 0.218, suggesting that the covariance matrices for each group were statistically substantially different from one another and that the homogeneity assumption met the threshold (p >.05).

Table 2: The result of multivariate

Source of Variance	Wilks' Lambda	F	Df_1	Df_2	Sig. (P)	Eta Squared (X^2)	Observed Power
Intercept	.006	1045.774	4.000	25.000	.000	.994	1.000
PBL (Approach)	.412	8.913	4.000	25.000	.000	.588	.997

Source: Field survey (2024)

The PBL approach's MANOVA results across several dependent variables are shown in Table 2. Multivariate analysis of variance frequently makes use of Wilks' Lambda (MANOVA). The PBL technique accounts for 58.8% of the variation, with a value of 0.412 meaning that 41.2% of the variance is not explained. The multivariate effect of PBL is confirmed to be significant by the F-value of 8.913 and the p-value of 0.000. The results of the multivariate tests clearly indicate that the PBL method affects the combination of Interest, Efficacy, Perception, and Anxiety in a substantial way.

Table 3: The result of ANOVA

Dependent Variable		Sum of Squares	Df	Mean Square	F	P- value	Eta Squared (X^2)	Observed Power
INTEREST	Contrast	.000	1	.000	.000	1.000	.000	.050
	Error	4.738	28	.169				
SELF -EFFICACY	Contrast	.963	1	.963	5.820	.023	.172	.644
	Error	4.633	28	.165				
PERCEPTION	Contrast	7.837	1	7.837	26.521	.000	.486	.999
	Error	8.274	28	.296				
ANXIETY	Contrast	.638	1	.638	3.171	.086	.102	.405
	Error	5.633	28	.201				

Source: Field survey (2024)

The table 3presents the results of Univariate Tests, which further examine the impact of the Project-Based Learning (PBL) approach on four dependent variables: Interest, Efficacy, Perception, and Anxiety. This supports the previous univariate findings, which shown significant impacts on perception and efficacy and maybe smaller effects on interest and anxiety.

H1:The F-value is 0.000 with a p-value of 1.000, indicating no significant effect of the PBL approach on student interest. The Partial Eta Squared is 0.000, meaning PBL explains none of the variance in interest. The observed power of 0.050 is very low, further indicating that the test had a very low chance of detecting an effect if there were one.Hencethe PBL approach has no significant impact on students' interest.H2:The F-value of 5.820 with a p-value of 0.023 indicates a statistically significant effect of the PBL approach on students' efficacy. The Partial Eta Squared of 0.172 shows that about 17.2% of the variance in efficacy is attributable to PBL. The observed power of 0.644 suggests a reasonable likelihood of detecting an effect. Therefore,the PBL approach significantly improves students' efficacy.H3:The F-value of 26.521 with a p-value of 0.000 shows a highly significant effect of the PBL approach on students' perception. The Partial Eta Squared of 0.486 indicates that 48.6% of the variance in perception is explained by PBL. The observed power of 0.999 is very high, meaning the test had a very high probability of detecting a true effect. Hence, the PBL approach has a strong, positive impact on students' perception.H4:The F-value of 3.171 with a p-value of 0.086 suggests a no significant effect of the PBL approach on students' anxiety, though it is near the threshold of significance (p = 0.05). The Partial Eta Squared of 0.102 indicates that about 10.2% of the variance in anxiety is attributable to PBL. The observed power of 0.405 is relatively low, meaning the test had a moderate chance of detecting an effect.Therefore,the PBL approach does not significantly affect students' anxiety, though it is close to the threshold of significance.

Table 4: The result of the estimate on the independent groups with the dependent variables

				95% Confidence Interval	
Dependent Variable	PBL(Approach)	Mean	Std. Error	Lower Bound	Upper Bound
INTEREST	Students taught with PBL approach	4.175	.106	3.957	4.393
	Student taught without PBL approach	4.175	.106	3.957	4.393
SELF - EFFICACY	Students taught with PBL approach	3.908	.105	3.693	4.123
	Student taught without PBL approach	3.550	.105	3.335	3.765
PERCEPTION	Students taught with PBL approach	4.178	.140	3.890	4.465
	Student taught without PBL approach	3.156	.140	2.868	3.443
ANXIETY	Students taught with PBL approach	3.883	.116	3.646	4.121
	Student taught without PBL approach	4.175	.116	3.6938	4.412

Source: Field survey (2024)

The data provided in table 4 involves a comparison between students taught with and without a Project-Based Learning (PBL) approach across different variables: Interest, Efficacy, Perception, and Anxiety. The estimates provided include the mean, standard error, and 95% confidence intervals.

Both groups (taught with and without PBL) have the same mean score of 4.175. This indicates that, on average, students' interest levels are the same regardless of whether they were taught using the PBL approach or not.The 95% confidence interval for both groups range from 3.957 to 4.393. Since the intervals are identical, there is no statistically significant difference in interest between the two groups

Students taught with the PBL approach have a higher mean efficacy score (3.908) compared to those taught without it (3.550).The 95% confidence intervals for the PBL group (3.693 to 4.123) and the non-PBL group (3.335 to 3.765) do not overlap, indicating a statistically significant difference in efficacy, with PBL being more effective.

The mean perception score is higher for students taught with PBL (4.178) compared to those without (3.156).The 95% confidence intervals for the PBL group (3.890 to 4.465) and the non-PBL group (2.868 to 3.443) also do not overlap, signifying a statistically significant positive impact of PBL on students' perception.

Students taught with PBL have a mean anxiety score of 3.883, while those taught without it have a mean score of 4.175.The 95% confidence intervals for the PBL group (3.646 to 4.121) and the non-PBL group (3.938 to 4.412) slightly overlap at the boundaries. This suggests that there is no strong evidence of a statistically significant difference in anxiety levels between the two groups, although students without PBL seem to experience slightly higher anxiety.

Discussion and Conclusion

This study aimed to investigate the impact of the Project-Based Learning (PBL) approach on students' Interest, Efficacy, Perception, and Anxiety. The results from both univariate and multivariate analyses provide clear insights into how PBL influences these key educational outcomes.

The analysis revealed that the PBL approach does not significantly affect students' interest in learning. The finding is not in line with a study by Abate etal. 2022), where they found out that, VT and VT-PBLA has significant effect on student interest (enjoyment) in mathematics, instead in line with PBLA which has no effect on enjoyment (interest). Both univariate and multivariate tests indicated no discernible difference in interest levels between students taught with PBL and those taught without it. The result is in line with Abate et al. (2022), where PBLA has no effect on enjoyment in mathematics with the group taught with PBLA. Again, the result is contrary with Zamir et al (2022) that Student Mathematics Motivation Scale (M) had significant effects on Students' Attitude Toward Problem-Based Learning (ATPBL), but Attitude Toward Enjoyment inMathematics Scale (AE) did not significantly

affect the ATPBL. The finding that PBL has no effect on students' interest is also not in line with some studies: PBL has been demonstrated in studies to boost students' interest in mathematics. Students who engaged in PBL had a much higher interest in mathematics than those who got conventional education, according to 2004 research by (Hmelo-Silver, 2004). PBL enhanced students' enthusiasm in mathematics and resulted in a deeper understanding of the topic, according to(Walker & Leary, 2009). Improving elementary school students' mathematics literacy through problem-based learning and practical instruction. He found that the interplay between the model problem-based learning and the direct instruction models had a significant impact on the development of mathematical literacy in elementary school students.

The PBL approach was found to significantly enhance students' sense of efficacy. Students taught using PBL reported higher levels of confidence in their abilities compared to those not exposed to PBL. This suggests that PBL can be an effective strategy for boosting students' self-confidence and belief in their problem-solving skills. The finding is in line with a study by Abate etal. 2022), where they found out that, VT and VT-PBLA has significant effect on student Self efficacy (Confidence) in mathematics. It confirms the findings by Bandura (1997) and Schunk (2023) whose study e indicated that PBL can raise students' mathematical self-efficacy. Students that are engaged in PBL had a considerable boost in their self-efficacy in mathematics.

One of the most significant findings of this study is the strong positive impact of PBL on students' perceptions. Students who participated in PBL had a markedly better perception of their learning experience. The finding confirms studies on PBL and students' perception and it was revealed that, PBL can have a favorable impact on how children view mathematics.According to (Lester, 2013)study, students who engaged in PBL had more favorable opinions of mathematics and believed it to be more relevant and helpful.According toRasmussen(2014)findings, PBL helped pupils appreciate and love mathematics more.

This finding suggests that PBL not only improves how students view the subject matter but also enhances their overall learning experience, hence their performance in mathematics. The result agrees with a study that identified problem-based learning approach enhanced students' academic performance in Mathematics ($F1, 108= 7.130$; $p = (.009) < .05$). This means PBL is practically effective for teaching and learning of mathematics (Ogunsola et al, 2021)

While the PBL approach did not significantly reduce students' anxiety levels, the results were close to the threshold for significance. This suggests that while PBL may not drastically lower anxiety, it might still contribute to a more relaxed and less stressful learning environment. The finding that PBL not reducing students' anxiety is not in line with studies that found out that, problem-based learning (PBL) can help students feel less anxious when it comes to mathematics. Hembree (1991) study found that students who engaged in PBL had significantly lower math anxiety than those who received traditional instruction. PBL helped students feel less anxious about math and increased confidence in their problem-solving skills(Newman, 2012).

The multivariate tests confirmed a significant overall effect of PBL on the combined dependent variables. Specifically, 58.8% of the variance in students' Interest, Efficacy, Perception, and Anxiety could be explained by whether or not they were taught using the PBL approach. This highlights the robust influence of PBL on the educational experience as a whole. This is in line with the studies that PBL utilization have influence on teaching and learning of a concept in the educational setting (Issa &Khataibeh, 2021;Ogunsola et al ,2021; Azila et al, 2022; Zamir etal. 2022)

Suggestions and Recommendation

The findings suggest that while PBL may not necessarily spark increased interest or substantially reduce anxiety, it is highly effective in enhancing students' self-efficacy and positively shaping their perception of learning. Educators might consider incorporating PBL into their teaching strategies and content of text books to promote a more positive and effective learning environment, particularly in areas where building students' confidence and perception of their capabilities is crucial.

Future research could explore ways to optimize PBL for reducing anxiety and further enhancing student interest, potentially leading to even more comprehensive benefits for learners.

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