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Development of A Problem-Based Learning Model to Improve Students' Numeracy and Self-Efficacy

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ABSTRACT

Education in Indonesia requires development, particularly in students' numeracy skills and self-efficacy (SE). The importance of numeracy skills is stated in the Graduate Competency Standards (SKL). Moreover, numeracy skills are also related to students' self-efficacy. Students with good numeracy skills tend to have high self-efficacy, and students with poor numeracy skills generally have low self-efficacy. Based on these factors, it is necessary to develop an appropriate learning model. The aim of this study is to develop a problem-based learning (PBL) model to enhance students' numeracy skills and self-efficacy, and to determine the feasibility of the developed product in improving students' numeracy and self-efficacy. This development research follows the ADDIE stages: Analyze, Design, Develop, Implement, and Evaluate. The research methods used were both quantitative and qualitative. Quantitative methods were employed to determine the level of feasibility of the developed product, while qualitative methods were used to describe the calculated feasibility scores, suggestions and comments from validators, teachers, and students. The results showed that the developed product met the criteria of validity and practicality but did not meet the criteria of effectiveness. The ineffectiveness of the product was due to students not being accustomed to using the PBL model and their unfamiliarity with discussion-based learning.

Keywords: mathematical literacy skills; numeracy; problem-based learning; self-efficacy

INTRODUCTION

Mathematics is a branch of knowledge used for learning as well as logical thinking, which underlies the development of modern technology. The importance of mathematics in human life, especially for students, lies in the fact that through mathematics, students can develop their thinking abilities such as reasoning, critical thinking, and logical analysis through mental activities related to mathematics learning (Kemendikbud, 2022). Therefore, mathematics instruction is mandatory in educational institutions. As we know, mathematics involves elements of calculation, and in our daily lives, we are never separated from counting. Hence, it is necessary for individuals to study mathematics.

Effective learning is learning that can achieve the intended learning outcomes. Learning outcomes refer to a set of competencies and scopes of learning material aligned with the curriculum of the educational unit (Permendikbudristek Nomor 16 Tahun 2022 Tentang Standar Proses). The learning outcomes for mathematics vary at each educational level. The way to achieve a learning objective is through implementing quality learning strategies. However, when designing learning strategies, educators need to consider student characteristics. One such characteristic is student prior ability. Students have diverse abilities, one of which is mathematical literacy.

The Ministry of Education and Culture (Kemendikbud) has launched the National Literacy Movement (Gerakan Literasi Nasional/GLN), which aims to develop a culture of literacy across various educational levels, including education in schools, communities, and families. This initiative seeks to improve quality of life through lifelong learning. In Indonesia, there are two types of literacy: reading literacy and mathematical literacy. Mathematical literacy is often referred to as numeracy. Numeracy is the ability to apply number concepts and calculation skills in everyday life, as well as the ability to interpret quantitative information found in our surroundings. Mathematical literacy is an important component in mathematics learning under the Merdeka Curriculum, which emphasizes contextual learning (Yaniawati et al., 2023). The importance of nurturing students' numeracy skills is stated in the Regulation of the Ministry of Education and Culture No. 5 of 2022, Article 5, which declares that the Graduate Competency Standards (Standar Kompetensi Lulusan/SKL) at each level of education focus on developing students' literacy and numeracy competencies in order to support their continued education.

Based on the results of the 2018 PISA study in Indonesia, students' performance in mathematical literacy or numeracy ranked 73rd with an average score of 379. More specifically, in the field of mathematics, only about 28% of Indonesian students reached Level 2, while the OECD average was 76%. At Level 5, only 1% of Indonesian students reached this level, compared to the OECD average of 11%. According to the Education Report, schools categorized as having good numeracy skills amounted to 36%, those in the moderate category were 45%, and those in the poor category were 22%. These results indicate that in the Special Region of Yogyakarta (DIY), particularly in Sleman Regency, students' numeracy skills still need improvement.

Ratnasari and Setiawan (2022) revealed that students' difficulties in solving problems include the ability to read and understand mathematical language and sentences, students' lack of prior knowledge, difficulties in formulating implementation strategies, and difficulties in drawing conclusions. According to Mahardika, Anwar, and Kusumasari (2024), students make mistakes in understanding numeracy problems due to their limited ability to interpret the information in the questions, lack of willingness to reread the questions, the complex nature of numeracy questions, and students rushing to complete them. Purnomo et al (2022)found that students in the new assessment did not experience interacting with numeracy related questions. According to Adawiyah, Maki, and Nisa (2023), low numeracy ability is caused by two factors: internal factors originating within the students themselves, such as attitude, intellectual level, and psychomotor skills; and external factors, which include the environment, school conditions, and inadequate facilities and infrastructure.

Improving numeracy skills also requires a positive student attitude. One such attitude that can enhance numeracy skills is self-efficacy (SE). SE influences students' mathematical literacy abilities (Atho'illah et al., 2022). In mathematics learning, SE is necessary because it reflects students' confidence in solving or completing a problem. Students with high SE tend to find it easier to solve mathematical problems, while those with low SE often struggle (Bandura, 1997). SE can influence the way a person thinks, feels, self-motivates, and acts (Bandura, 2009). This is because solving problems requires students to have self-confidence in order to successfully overcome the challenges they face. Students with high SE tend to have good numeracy skills, those with moderate SE have fairly good numeracy skills, while those with low SE tend to have poor numeracy skills (Nurtiana & Adirakasiwi, 2022).

However, students' SE remains relatively low. This is caused by several issues: 1) although students are interested in learning, they lack effective repetition strategies and are not fully confident in achieving high test scores; 2) students with lower cognitive levels may have good interest and strategies, but their confidence in obtaining good grades is still moderate (Putri & Prabawanto, 2019). Students with low SE are unable to solve problems correctly; they are only able to understand the problems presented (A. Rahmawati et al., 2021). SE also affects students in formulating information and interpreting mathematical problems (Via et al., 2021).

Lack of numeracy and SE can be overcome using a good learning model. One of the of the learning models that can assist students in solving mathematical problems and help them become more active and confident is the Problem-Based Learning (PBL) model. PBL is an effective learning model for improving students' mathematical abilities and encouraging active participation during the learning process (Yew & Goh, 2016). This indicates that the PBL model can enhance numeracy skills. Consistently, Firdaus et al. (2021) found that PBL has a positive and significant effect on improving numeracy skills. According to Setiani, Lukman, and Suningsih (2020), implementing PBL in the classroom can improve students' mathematical problem-solving abilities. Wardono et al., (2018) research resulted in PBL with a scientific approach that can improve numeracy skills.

By using PBL, understanding can be gained through students' interaction with problems and the learning environmentThis learning model is problem-oriented, so students become accustomed to dealing with problems throughout the learning process. The problems in PBL can be drawn from everyday life situations. Through the use of the PBL learning model, students are able to solve mathematical problems, including numeracy-related issues.

According to Fajriah, Utami, and Mariyam (2020) students' learning outcomes in statistical material are still considered low. This is because statistical topics, particularly those involving frequency distribution tables, involve a variety of formulas, which makes it difficult for students to solve the problems given. Research conducted by Gumilar and Effendi (2022) indicates that students have low learning interest in mathematics, especially in statistical material. Based on the results of the Minimum Competency Assessment (AKM) as presented in the senior high school education report, there has been an increase in the competency of data and uncertainty; however, the score improvement was only 4.60. In light of these issues, the researcher intends to develop a PBL learning model to improve students' numeracy and SE skills in mathematics, particularly in statistical topics. The product development aims to determine the feasibility of the product in terms of its validity, practicality, and effectiveness.

RESEARCH METHODS

1. Research Design
   This research uses the ADDIE (Analyze, Design, Develop, Implement, and Evaluate) development model. The stages involved are as follows:

a. Analyze

This stage involves gathering information from previous literature and analyzing research needs related to the curriculum, students, and materials. Information on previously used learning models, student characteristics, and issues related to student abilities is also collected.

b. Design

This stage involves designing the products to be used, including PBL learning model books, teaching modules, Numeracy Worksheets (LKPD), and self-efficacy questionnaires.

c. Develop

This stage involves developing the designed products, namely the PBL learning model, teaching modules, LKPD, self-efficacy questionnaires, and numeracy ability tests. After development, validation is carried out by experts. After being declared valid by the experts, the validated products are tested on a limited basis.

d. Implementation

This stage involves conducting a field trial after the limited trial. The field trial involved three schools with good and average performance.

e. Evaluation

At this stage, the research and development results are evaluated for validity, practicality, and effectiveness, and then the results are reported.

2. Participants

The trials were conducted in three schools: two categorized as having good numeracy and one categorized as moderate. Expert testing was carried out by subject-matter lecturers, while limited testing—specifically readability testing—was conducted with 30 twelfth-grade students who had already received statistics material. Field testing involved 49 students from the first good-category school, 37 students from the second good-category school, and 46 students from the moderate-category school. The trials used two classes: one control class that used a conventional learning model and one experimental class that used the developed learning model.

3. Instrumens

The data collection techniques and instruments used included: a product validity instrument, used by expert lecturers to assess the validity of the developed product; a readability instrument for limited testing, used by twelfth-grade students; a practicality instrument, used by both teachers and students to evaluate the implementation of learning after using the product; and an effectiveness instrument, used to determine improvements in students' numeracy ability and SE.

4. Data Analysis

The data collection techniques employed both quantitative and qualitative approaches. The qualitative approach was used to explain the results obtained from the quantitative data. The validity, categories can be seen in Table 1. An instrument is considered valid if it meets at least the "good" or can be seen in table 2.

Table 1. Conversion Guidelines from Actual Scores to a Five-Point Scale

Score Interval	Category
$x > (\bar{x_i} + 1,8\ SD_i)$	Very Good
$\bar{x_i} + 0,6\ SD_i) < x \leq (\bar{x_i} + 1,8\ SD_i)$	Good
$\bar{x_i} - 0,6\ SD_i) < x \leq (\bar{x_i} + 0,6\ SD_i)$	Fairly Good
$\bar{x_i} - 1,8\ SD_i) < x \leq (\bar{x_i} - 0,6\ SD_i)$	Less Good
$x \leq (\bar{x_i} - 1,8\ SD_i)$	Not Good

Explanation of Table 1:

$\bar{x_i}$ = Mean (average) ideal score = $\frac{Ideal\ maximum\ score + ideal\ minimum\ score}{2}$

SD_i = Ideal standard deviation = $\frac{Ideal\ maximum\ score - ideal\ minimum\ score}{6}$

x = Actual score
Ideal maximum score = number of criteria items × highest score
Ideal minimum score = number of criteria items × lowest score

Table 2. Validity Category Product

Product	Category good	Score Maximum
Problem-Based Learning Model Book	$71 < x \leq 88$	105
Learning Plan control/eksperiment class	$99 < x \leq 122$	145
Students Worksheets control/eksperiment class	$61 < x \leq 71$	85
Pre/posttest Control/Eksperiment Class	$41 < x \leq 50$	60
SE Quisionnare	$27 < x \leq 34$	40

Learning implementation is considered practical if at least 80% of all learning activities are carried out. In addition, the teacher and student practicality questionnaires must fall within at least the "good" category. For teacher good category in $40{,}8 < x \leq 50{,}4$ and for student in $30{,}6 < x \leq 37{,}8$. The practicality categories are also presented in Table 1. The product is considered effective if 80% of the students meet the Minimum Mastery Criteria (KKTP) with scores above 75, 80% of students achieve a "high" category in student engagement (SE), and the N-gain improvement falls within the "high" category, with a minimum N-gain score of ≥ 0.7.

RESULTS AND DISCUSSION

This study employed the ADDIE development model; therefore, the discussion is based on the stages of the ADDIE development model as follows:

1. Analyze

The results of the literature review indicate that numeracy skills are crucial for students in addressing problems encountered in everyday life that are related to mathematics. Students' attitudes also influence whether they are able to solve mathematical problems in daily life effectively or not. One of the most essential student attitudes needed is SE. However, Indonesia ranked 73rd out of 78 participating countries in the PISA assessmen (OECD, 2018). According to Adawiyah, Maki, and Nisa (2023), the low level of numeracy skills is influenced by two factors: internal and external factors. Internal factors are aspects that originate within the students themselves, such as attitudes, intellectual level, and psychomotor abilities. External factors include environmental conditions, school conditions, and inadequate facilities and infrastructure. The internal factor namely students' attitudes originating from within themselves is related to Bandura (Bandura, 1997), who stated that students with high SE tend to find it easier to solve mathematical problems, while those with low SE tend to struggle.

Based on the findings of Putri and Prabawanto (2019), it was found that students' SE falls into the moderate category. This is because most students lack confidence in their own abilities; many students actually possess high potential but lack self-confidence, resulting in their abilities being suboptimally utilized in learning. Based on this literature review, the researcher aims to develop a PBL to improve students' numeracy skills and SE.

2. Design

The products used in this research are a learning model book, Student Worksheets (LKPD), teaching modules, numeracy ability tests, and a self-efficacy questionnaire. The resulting product designs are as follows:

a. PBL Learning Model Book

Consists of an introduction, theoretical basis, and a review of the PBL learning model. This book is designed based on the PBL steps: connecting with the problem; setting up the structure; visiting the problem; revisiting the problem; producing a product or performance; and evaluating performance and the problem. Each PBL step relates to numeracy and SE.

b. LKPD

Consists of the LKPD identity, learning objectives for each session, problems related to daily life, creating a problem-solving platform, and conclusions. LKPD is designed to help students improve their numeracy and SE skills.

c. Teaching Module

Consists of the identity, time allocation, learning outcomes (CP), learning objectives, learning objective flow, learning activities, media/tools and learning resources, and assessment. The teaching module is designed to help teachers design learning that is appropriate to PBL to improve numeracy and SE skills.

d. Numeracy ability test

Consists of a pretest and posttest using the same grid.

e. SE Questionnaire

Consists of 15 positive statement items and 15 negative statement items on a Likert scale with 5 values.

3. Develop

Development develops the product from design to a product that will be tested. The result of development is called draft 1. The products developed are as follows:

a. Development of a PBL learning model book

Book development follows the design. PBL development is based on syntax oriented towards students' numeracy and SE skills, as shown in Table 3.

Table 3. Phases of Problem-Based Learning

Stages/Phases	Activity
Stage 1: *Connecting with the problem*	The teacher presents a daily life problem related to the students.
Stage 2: *Setting up the structure*	Student create a plan to solve the problem.
Stage 3: *Visiting the problem*	Students seek information about the problem to solve it. The teacher circulates around checking students' work and providing assistance to those experiencing difficulties. At this stage, the teacher acts as a resource person and facilitator for the students.
Stage 4: *Revisiting the problem*	Students review their work. The teacher instructs students to submit their work.
Stage 5: *Producting a product or performance*	The teacher provides an opportunity for students to present the results of their discussions. At this stage, the teacher also evaluates the students.
Stage 6: *Evaluating performance and the problem*	The teacher encourages students to reflect on and summarize the material they have learned.

b. Developing a teaching module

The development of the teaching module is separated by learning objectives and learning activities at each meeting. The teaching module consists of seven meetings, with the first meeting being a pretest and the last meeting being a posttest.

c. Developing Student Worksheets (LKPD)

The development of the LKPD is tailored to the learning objectives at each meeting. Development is carried out based on a previously created design. One example of a numeracy-oriented LKPD question can be seen in Figure 1. The LKPD is completed in groups. By using the questions provided in the LKPD, students are expected to not only improve their numeracy skills but also improve their SE through group work.

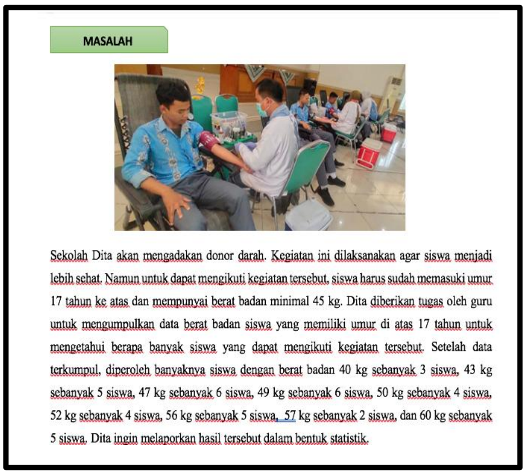

Figure 1. LKPD Questions

d. Numeracy Ability Test Development

The numeracy ability test uses multiple-choice, complex multiple-choice, matching, short answer, and essay questions. A total of 19 questions are presented, each consisting of 6 multiple-choice, 2 complex multiple-choice true-false, 1 matching, 3 short answer, and 7 essay questions.

e. SE Questionnaire Development

The SE pretest and posttest used the same questionnaire. There are 30 items, 15 positive and 15 negative. Assessment is carried out on a 5-point Likert scale, with a maximum score of 5 for each item and a minimum score of 1.

3. Implement dan Evaluate

The product was first tested by experts, resulting in the learning model book, teaching modules, LKPD, numeracy skills test, and SE questionnaire being categorized as valid. The validity results of the product can be seen in Table 4.

Table 4. Product Validity Results

No.	Development Products	Score	Validity Criteria
1.	Problem-Based Learning (PBL) Model Book	91	Very Valid
2.	Teaching Module for the Experimental Class	126	Very Valid
3.	Teaching Module for the Control Class	123	Very Valid
4.	LKPD for the Experimental Class	73	Very Valid
5.	LKPD for the Control Class	70	Valid
6.	Numeracy Skills Pre-Test	55	Very Valid
7.	Numeracy Skills Post-Test	55	Very Valid
8.	SE Questionnaire	35	Very Valid

Furthermore, a limited trial was conducted in Grade XII, which resulted in a high-quality LKPD. The trial of the LKPD product for the experimental class obtained an average score of 39.3, categorized as very good, while the trial of the LKPD product for the control class obtained an average score of 39.13, also categorized as very good. The trial of the LKPD product for the experimental class obtained an average score of 39.3, categorized as very good, while the trial of the LKPD product for the control class obtained an average score of 39.13, also categorized as very good. The results of the readability test by teachers showed that the products namely the PBL model book, teaching modules, LKPDs, and numeracy skills tests met at least the minimum criteria of "good," as shown in Table 5.

Table 5. Teacher Readability Results

No.	Product	Total Score	Average	Category
1	Learning Model Book	308	102,67	Very Good
2	Experimental Teaching Module	399	133,00	Very Good
3	Control Teaching Module	396	132,00	Very Good
4	Experimental LKPD	229	76,33	Very Good
5	Control LKPD	228	76,00	Very Good
6	Numeracy Skills Pre-Test	133	44,33	Good
7	Numeracy Skills Post-Test	137	45,67	Good

After the limited trial was conducted, a field trial was subsequently carried out in three schools: two schools in the "Good" category and one school in the "Medium" category. The description of the results per school is as follows:

a. Good School 1

1) Numeracy Skill

The implementation of learning at this school was carried out over six meetings, with at least 80% of each meeting being implemented. Therefore, in terms of practicality, Good School 1 has good practicality. The results showed that 36.36% of students in the control class achieved a score of 75 or higher and 24% in the experimental class. Both classes did not meet the effectiveness criteria, which requires at least 80% of students to achieve a minimum score of 75 or higher. The results of the difference in the average pretest and posttest for numeracy skills showed a significance value of 0.000 for the experimental class and 0.000 for the control class, indicating that both classes showed similar differences after the treatment. Furthermore, the Ngain results were 0.5325 for the control class and 0.5247 for the experimental class. Table 6 shows that both Ngain results are in the moderate category.

Table 6. N-Gain Index Criteria

No.	Indeks N-Gain (< g >)	Kriteria
1.	$(< g >) \geq 0{,}70$	High
2.	$0{,}30 \leq (< g >) < 0{,}70$	Medium
3.	$(< g >) < 0{,}30$	Low

Therefore, the effective criteria for improvement were not met. An item analysis of the numeracy posttest was then conducted to determine the reasons for the ineffectiveness of PBL in improving numeracy and SE. Five out of 19 questions differed in difficulty between the control and experimental classes. This indicates that the numeracy skills of the control and experimental classes were nearly identical, as 14 questions had the same level of difficulty between the two classes. These results suggest that PBL may be ineffective in improving numeracy and SE because the students' abilities in the control and experimental classes were similar.

2) SE

SE resulted in 80% of students achieving the minimum high category. However, after testing the differences between the pretest and posttest, SE showed no difference with a significance value of 0.183 for the control class and 0.013 for the experimental class, indicating a significant difference. However, this difference resulted in a negative Ngain value of -0.1055, indicating a decrease in SE.

The reasons for the decrease in SE can be seen in Figures 2 and 3, which represent student feedback after completing the entire learning process. From these two inputs, it can be concluded that students disliked group learning in both the control and experimental classes. This also affected the students' posttest results, which did not reach 80% of students achieving the KKTP (competitive minimum score). This is despite the fact that both the control and experimental classes utilized group discussions from the beginning to the end of the lesson. Because students disliked group learning, learning could become boring. Consequently, there was no improvement in students' self-efficacy and no difference was found.

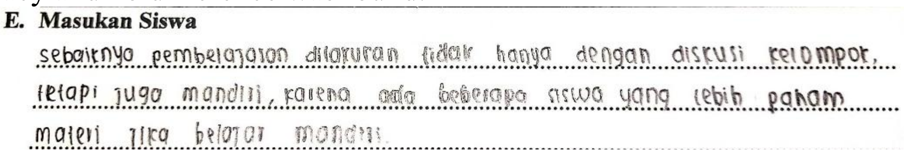

Figure 2. Student Input from the Control Class

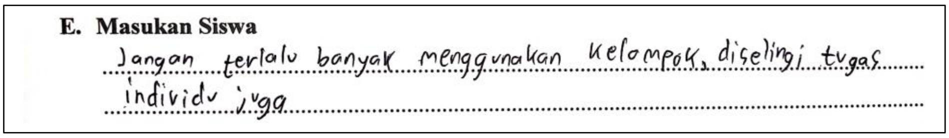

Figure 3. Student Input from the Experimental Class

SE results were related to numeracy results. In both the control and experimental classes, SE with very high scores had very high, high, and sufficient numeracy skills. SE with high scores had very high, high, and sufficient numeracy skills. Meanwhile, SE with sufficient scores had low numeracy skills. From these results, it can be concluded that high SE indicates high numeracy skills. However, low SE indicates low numeracy skills.

b. Good School 2

1) Numeracy Skills

The implementation of learning at this school was carried out over six meetings, with at least 80% of each meeting being implemented. Therefore, in terms of practicality, Good School 2 has good practicality. The results showed that 0% of students achieved a score of more than 75 in the control class and 10% in the experimental class. Both classes failed to meet the effectiveness criteria, which is at least 80% of students achieving a minimum score of 75. The results of the difference in the average pretest and posttest for numeracy skills showed a significance value of 0.000 for the experimental class and 0.000 for the control class, indicating that both classes showed similar differences after the treatment. Furthermore, the Ngain results were 0.3933 for the control class and 0.2989 for the experimental class.

An item analysis of the numeracy skills posttest was conducted to determine the reasons for the ineffectiveness of using PBL to improve numeracy and SE. Six questions were classified as easy, seven as medium, and six as difficult in the control class. Meanwhile, based on the difficulty level analysis for the experimental class, three questions were classified as easy, 10 as medium, and six as difficult. These results revealed that more easy questions were found in the control class than in the experimental class, while the number of difficult questions was the same. This suggests that PBL is likely ineffective in improving numeracy and SE skills.

2) SE

Meanwhile, for SE, 80% of students achieved the minimum high category. However, after testing the differences between the pretest and posttest, SE showed no difference with a significance value of 0.736 for the control class and 0.919 for the experimental class. As seen in Table 6, the Ngain score reached the moderate category. Therefore, the effective criteria for improvement were not met.

The dimensional analysis also concluded that posttest results did not reach 80% of students achieving the KKTP (National Competency Standards). This likely occurred because students lacked learning resources from the school, which led to confusion when given worksheets without prior instruction. This is evidenced by Figures 4 and 5, which represent student suggestions after completing all sessions. However, both the control and experimental classes used student worksheets from the beginning to the end of the lesson. Therefore, there was no improvement or difference in student SE.

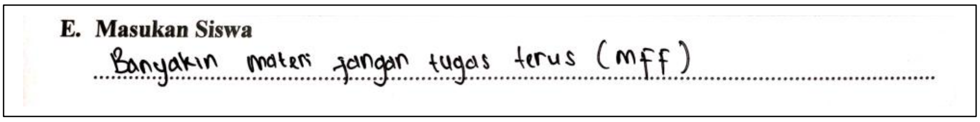

Figure 4. Student Feedback from the Control Class

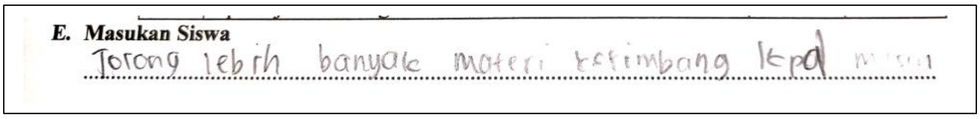

Figure 5. Student Feedback from the Experimental Class

SE results are related to numeracy results. In the control class, SE was categorized as very high and high, with sufficient and low numeracy skills. Meanwhile, in the experimental class, SE was categorized as very high, with very high, sufficient, low, and very low numeracy skills. High SE was categorized as high, sufficient, and low numeracy skills. Therefore, there is no correlation between SE and numeracy skills. The results indicate that high SE does not necessarily result in high numeracy skills.

c. Medium School

1) Numeracy Skills

The implementation of learning at this school was achieved over six meetings, with at least 80% of each meeting being implemented. Therefore, in terms of practicality, the school is considered to have good practicality. The results showed that no students scored above 75 in either the control or experimental classes. Both classes failed to meet the effectiveness criteria, which requires at least 80% of students to achieve a minimum grade point average (KTTP) of 75 or higher. The significance value for the difference between the pretest and posttest averages for numeracy ability was 0.000 for the experimental class and 0.000 for the control class, indicating that both classes had similar differences after the treatment. Furthermore, the Ngain score was 0.2169 for the control class and 0.3150 for the experimental class. These results categorize the Ngain scores as low and medium.

An item analysis of the numeracy ability posttest was conducted to determine the reasons for the ineffectiveness of PBL in improving numeracy and SE. Therefore, the effectiveness criteria for improvement were not met. Based on the analysis of the difficulty level of the control class in Table 62, 4 questions were classified as easy, 7 questions as medium, and 8 questions as difficult. Meanwhile, based on the analysis of the difficulty level of the experimental class in Table 62, 4 questions were classified as easy, 7 questions as medium, and 8 questions as difficult. These results indicate that the number of questions classified as easy, medium, and difficult was equal in both classes. This makes PBL ineffective for improving numeracy skills, as the abilities of both classes remained the same despite the different treatments.

2) SE

The SE resulted in 80% of students achieving the minimum high category. However, after conducting a difference test for pretest and posttest results, the SE showed no difference with a significance value of 0.215 for the control class and 0.243 for the experimental class. The reason for the lack of difference between the control and experimental classes is likely due to a lack of interest in mathematics in both classes. Figures 6 and 7 show student feedback after completing the entire learning process. From these feedbacks, it can be concluded that students disliked mathematics learning in both the control and experimental classes. This also affected the posttest results, as no students achieved the minimum competency criteria (KKTP). Therefore, there was no difference in the students' SE.

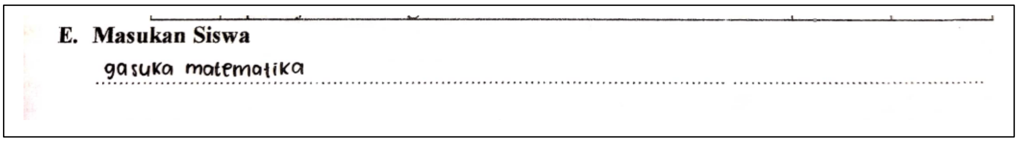

Figure 6. Student Feedback from the Control Class

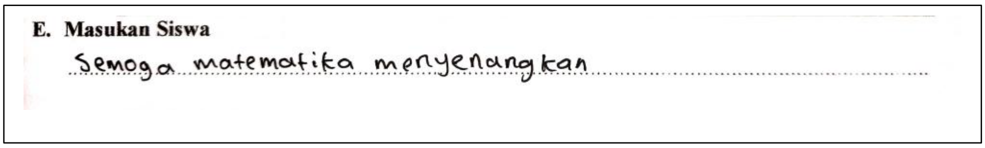

Figure 7. Student Feedback from the Experimental Class

The SE results can be linked to numeracy results. In the control class, SE in the very high category had high, moderate, low, and very low numeracy skills. SE in the high category had moderate, low, and very low numeracy skills. Meanwhile, in the experimental class, SE in the very high and high categories had moderate and low numeracy skills. These results indicate no correlation between SE and numeracy ability. Results obtained in medium-sized schools indicate that high SE does not result in high numeracy ability. Mellyzar et al (2022)stated that the effect of SE on students' numeracy ability was 49.5%. Via, Tatag, and Abadi (2021) also explained that the effect of SE on numeracy was only 20.1%. According to them, numeracy ability is influenced by factors other than SE. However, this study did not examine these other factors. This suggests that high SE does not necessarily imply high numeracy ability.

From the results of research in the three schools, it can be summarized several things that cause the PBL learning model in improving numeracy and SE skills to be ineffective, including: 1) students are not yet accustomed to the PBL learning model; 2) lack of learning time so that learning is ineffective, this can be seen from the initial design of the researcher in one meeting takes 90 minutes, while in reality the time needed is only 60 minutes for one meeting, some even only 45 minutes; 3) students do not like learning in groups, even though learning in groups is an important aspect in the PBL learning model; 4) students do not like learning with LKPD, students prefer to be given material such as lecture methods; 5) students do not like mathematics subjects; and 6) lack of learning resources owned by students.

The results of the effectiveness of this study are not similar to those of other studies that met the criteria of effectiveness (U. Rahmawati, 2013;Nurwidyastuti & Wutsqa, 2016). However, there are studies that did not meet the criteria of effectiveness, such as the study by Susanti (2022). In Eliyana's (2014) study, it was stated that the PBL learning model showed no difference compared to the conventional learning model. Ariyanti (2017) stated that the PBL learning model was ineffective when viewed from the perspective of students' academic achievement. Meanwhile, in the study by Hardiyanto and Santosa (2018), PBL in terms of SE showed no difference between PBL with the Think-Talk-Write setting and PBL with the Think-Pair-Share setting. These findings are consistent with the present research, which found that the numeracy ability test results were ineffective, and in terms of SE, there was no significant difference.

According to Hardiyanto and Santoso (2018), the reason for the absence of differences in SE is that teachers still play a major role in assisting, directing, and guiding students. According to them, this occurs because students are not yet accustomed to using the PBL model. The assumption in this study is not much different from that of Hardiyanto and Santoso (2018). Students are still unfamiliar with the PBL model, especially those who face difficulties accessing learning resources. Another assumption is that the use of group discussions in the learning process affects students' SE, as some students do not enjoy group learning, which is essential for SE that emphasizes collaboration.

The limitations of researchers in conducting research include; sudden changes in school hours made researchers unable to manage their time well, because in one day the researchers conducted research in two schools; reduction of mathematics lesson hours at school because some of the mathematics lesson hours were used for P5, namely student profile development activities, so that mathematics lesson hours were reduced; placement of mathematics lesson hours placed after sports lessons made students tired so that students were not enthusiastic about learning, and some students asked for permission to leave the class to change clothes so that mathematics lesson hours were reduced; there were no permanent learning resources used by the school so that students were confused in solving problems because of limited learning resources; pretest SE from the three schools was already high, this became a weakness of the researcher, namely lack of care in conducting initial observations on students at school. The researcher's suggestions to overcome these things are to be more careful in conducting initial observations, use lesson hours well by not providing statistical material with PBL when lesson hours are reduced, or providing statistical material with more than seven meetings, and preparing learning resources as complete as possible.

CONCLUSION

Based on the research questions and the research results that have been concluded, it can be concluded that the research produces a PBL learning model with good product validity and practicality, but for effectiveness in each school, both good and medium, it has not met the criteria for effectiveness in students' numeracy skills, while students' SE has no difference. This is caused by several things, namely, students are not yet accustomed to the

PBL learning model, lack of learning time, students do not like learning in groups, students prefer learning with lecture methods, and students do not like mathematics subjects.

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