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Application of the problem based learning model and guided inquiry on learning outcomes and student interest

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ABSTRAK

Penelitian ini bertujuan untuk mengetahui apakah terdapat perbedaan dengan penerapan model pembelajaran berbasis masalah dan inkuiri terbimbing terhadap hasil belajar dan minat siswa. Sifat penelitian adalah eksperimen semu dengan desain kelompok kontrol pre-test dan post-test. Sampel penelitiannya adalah Kelas XI IPA 2 sebagai kelas eksperimen I dengan menggunakan model pembelajaran berbasis masalah dan Kelas XI IPA 4 sebagai kelas eksperimen II dengan menggunakan model inkuiri terbimbing. Hasil penelitian menunjukkan bahwa terdapat perbedaan hasil belajar dan minat siswa pada materi asam dan basa, dengan rata-rata nilai post-test Kelas Eksperimen I sebesar 88,90 dan rata-rata minat akhir sebesar 83,12; kelas adalah 83,12.Kelas II sebesar 88,90, 86,62 dan hasil akhir sebesar 82,46.Hasil temuan menunjukkan bahwa terdapat perbedaan hasil dan minat belajar siswa, serta terdapat korelasi positif antara minat dan hasil belajar pada kedua model. Kami berharap hasil penelitian ini dapat membantu para pendidik memahami dan menerapkan model pembelajaran yang inovatif dan efektif kepada siswa.

ABSTRACT

This study explores the differences between the application of problem-based learning models and guided inquiry on students' learning outcomes and interest. This research is a pseudo-experiment with a pre-test and post-test control group design. The research sample consisted of students in the eleventh grade 2 science class who served as the experimental class I using a problem-based learning model and students in the eleventh grade 4 science class as the experimental class II using the guided inquiry model. The results showed differences in learning outcomes and student interest in acid and base materials, with an average post-test score of 88.90 and an average final interest of 83.12 from Experimental Class I. Meanwhile, the experimental class II attained an average post-test score of 88.90, 86.62 and the final result was 82.46. The findings indicated differences in student learning outcomes and interest, with a positive correlation between interest and learning outcomes in both models. It is hoped that the results of this study will assist educators in understanding and applying innovative and effective learning models to students.

INTRODUCTION

Given the pivotal role of education in the development of human life, it becomes an imperative necessity that must be met throughout one's lifetime. Changes in the educational system serve as one effort that must be performed in order to achieve educational goals (Laras & Rifai, 2019). According to Law No. 20 of 2003, which oversees the National Education System, education is defined as a deliberate and intentional endeavor to establish a learning environment and an engaging learning experience. Educators modify the value of educational information and talents to align with current competency criteria (Rahman, 2022). According to the Republic of Indonesia Minister of National Education Regulation No. 22 of 2006, chemistry courses must provide students with the necessary knowledge, comprehension, and a variety of abilities to enter a higher level of education and advance their knowledge and technology (Fajrin et al., 2020). Yul et al., (2020) defined chemical integration as the systematic study of ideas through the integration of theoretical and mathematical principles. While memory is a fundamental aspect of learning chemistry, effective chemistry learning requires the construction of knowledge (Rahayu & Sari, 2023). Chemistry is frequently identified as one of the core subjects at all educational levels. Numerous misconceptions, challenging tasks, and a deficiency in problem-solving abilities that impair students' cognitive achievement, critical thinking abilities, and attitudes toward science make this clear (Wahyudiati, 2022). Acids and bases have been identified as the most challenging chemical topics covered in eleventh-grade high school. Previous research has demonstrated that children have difficulty comprehending acid-base composition. This is due to the fact that the material is intricate and interwoven, necessitating a comprehensive understanding of each subject (Utami et al., 2020). According to Bronsted Lowry and Lewis, students continue to encounter difficulties in differentiating between weak and strong acids, as well as understanding acid-base theory. Another challenge in teaching chemistry in schools is the overreliance on textbooks, with hands-on activities being employed less frequently (Awalliyah, 2022). According to Andriani et al., (2019), this approach frequently results in pupils' failure to grasp the subject matter.

The findings of an interview conducted with eleventh-grade chemistry teachers in State Senior High School 10 Medan indicate that a significant number of students who have taken the chemistry exam have received low scores. Several students score below the predetermined minimum score criteria of 70, with the eleven science 2 class failing the acid-base portion of the test at 65.72% and the eleven science 2 class failing the test at 57.14%. The lack of student interest in acid-base material contributes to suboptimal learning outcomes, particularly with regard to calculating acidic and basic solutions. It also reduces student participation in class, as students frequently listen to the teacher's explanation. Through the use of teacher-centered instruction, instructors impart knowledge to students without enabling them to fully comprehend the idea of application. The low level of student interest and involvement has prompted a number of questions about the effectiveness of teacher-centered instruction (Aidoo et al., 2022). To boost student engagement and achieve learning objectives for chemistry learning, instructors must be aware of and utilize cutting-edge learning strategies. According to Sutrisno(2020), the outcome of learning represents the totality of a student's endeavors directed toward the achievement of learning objectives. Further, the chemical material is challenging, which lowers student interest and learning outcomes. One can leverage interest as an internal motivator to complete a task. Interest is defined as a psychological component that influences learning outcomes that are related to students' learning results in chemistry classes. This implies that learning outcomes will increase with students' enthusiasm in learning chemistry. Consequently, students' interest plays a significant part in their learning of chemistry (Sari et al., 2020). Teachers' less creative approach to teaching, in which students' involvement with the material they encounter is considered as learning, is the source of low student interest and poor learning outcomes. The teacher's role in this process is to facilitate learning and steer pupils toward appropriate learning. To encourage meaningful learning, instructors should show students how to connect abstract scientific ideas to real-world concerns (Raman et al., 2024)

One potential solution to this issue is to select a new learning model during instruction, which has been demonstrated to enhance student engagement and achievement. Guided inquiry and PBL

(Problem-Based Learning) are two learning paradigms that have been demonstrated to increase student interest and learning outcomes. The two learning models exhibit notable differences. The specific nature of the problem and the desired outcomes serve to differentiate between the two models. A closed problem serves as the essence of guided inquiry learning. In other words, the problem has a known solution. Consequently, the instructor is already aware of the solution to the subject matter under study and merely withholds this information from the students. When using the PBL paradigm for learning, as opposed to guided inquiry learning, the problem is oped with no known solution. PBL promotes problem-solving skills and helps students build a self-directed learning style. It supports students' individual learning paradigm by fostering teamwork toward a shared learning goal (Magaji, 2021). PBL provides students with active learning tools while focusing the lesson on problems. Students may be motivated by problems to learn, communicate, and build arguments for suggested solutions (Suradika et al., 2023). Through opportunities for group discussions, self-generated problem solutions, and public presentations of the discussion's outcomes, PBL fosters students' ability to collaborate with one another and communicate effectively while they learn (Nora et al., 2023).

The term inquiry comes from the English word "inquiry," which can indicate inquiry, examination, or research. In using guided inquiry as a learning model, students must actively participate in problem-solving with teacher guidance. Meanwhile, the teachers must be qualified to diagnose students' difficulties, offer support in problem solving, and pay close attention to aspects of divergent thinking, such as convergent and creative thinking (Ledoh et al., 2021). Further, inquiry based learning can increase student engagement, academic achievement, scientific process skills, environmental attitudes and higher order thinking skills (Rahmatilah et al., 2022). Inquiry-based learning improves students' comprehension and critical thinking abilities, resulting in greater learning outcomes. This results in attitudes and actions that facilitate all students' ability to engage in rigorous, critical, logical, and analytical inquiry and study, thereby enabling them to confidently articulate their findings (Gunawan et al., 2024). Meanwhile, guidanced inquiry and learning-based learning are critical tools for improving teaching and learning. Experiments are one of the available learning method, while pragmaticum is one of the experimental procedures. One crucial component of chemistry education is the practicum, with students actively participate in practicum learning, where the teacher only acts as a facilitator. The practicum aims to improve knowledge of scientific concepts, foster enthusiasm and motivation, and strengthen problem-solving abilities (Abulais et al., 2023)

A number of studies have reported that guided inquiry and PBL approaches can boost learning outcomes and student engagement. According to Rombe et al.,(2022), students' scores increase by an average of more than 50%, proving the PBL learning paradigm's effectiveness in increasing students' interest in learning. Lumolos et al., (2019) discover that guided inquiry learning can spark students' curiosity about chemical topics, especially acid-base materials. Thus, the increase in students' average learning results in acid and base content suggests its suitability for high school instruction. Sulastry et al., (2023) have also reported students' learning outcomes before and after utilizing the PBL paradigm. The PBL model produced an N-gain value of 0.75, suggesting its suitability for high-level learning. Yusuf (2019) stated that the guided inquiry learning model facilitates one to draw students' interest and attention while actively immersing them in the proper learning process, thereby, resulting in increase of student learning outcomes by 93.33%. According to Anzani and Ismono's (2020) research findings, implementing the guided inquiry model improves classical learning outcomes, as evidenced by an increase in the average pretest to posttest results in acid and base material from 44.05 to 91.43, with increasing percentage of classical completeness from 0% to 96.43%.

METHOD

In this study, a quantitative approach was adopted because this research involving the processing of numerical data. In particular, this study utilized quasi-experimental research involving experimental group I and experiment II, with Pretest and Posttest Control Design. Two classes were involved as experimental classes to identify the differences in learning outcomes and student interest in learning by applying the Problem Based Learning (PBL) and Guided Inquiry learning models on acid-base material. To explore the different learning outcomes from the two learning models, pretests and posttests were employed, which consisted of 20 multiple choice questions with five options, namely A, B, C, D, and E . The items for these test had been validated. The research commenced with the procurement of pretests first in both experimental groups. Following the test, the Problem Based Learning (PBL) learning model was implemented in experimental class I and the Guided Inquiry learning model in experimental class II. After the application of the learning model in each class, a posttest was administered to determine student learning outcomes. The research design is summarized in Table 1.

Table 1. Research design

Class	Initial test	Treatment	Final test
Experiment I	T_1	X_1	T_2
Experiment II	T_1	X_2	T_2

Information :

X_1 = Experimental class I treatment, namely implementing a learning model Problem Based Learning (PBL)

X_2 = Experimental class II treatment, namely implementing the Guided Inquiry learning model

T_1 = Pretest

T_2 =Posttest

Student intest in learning was measured using a learning interest que. In the questionnaire, students' interest in learning was assessed through 25 positive statements with four indicators of interest, namely feelings of pleasure; student interest; student attention; student involvement. This questionnaire had ben validated. Additionally, a Likert scale was employed, wherein each statement was assigned four choices, each with a distinct score. These included strongly agree (score = 4), agree (score = 3), disagree (score = 2), and strongly disagree (score = 1). The implementation of this research was conducted following the administration of a preliminary test to students, who were subsequently administered a questionnaire regarding their initial interest in learning in both experimental groups. The groups were assigned a learning model, namely the Problem-Based Learning (PBL) model in experimental class I and the Guided Inquiry model in experimental class II. Following the implementation of the learning model in each class, a final interest questionnaire was administered to determine students' interest in learning. Once the data from the tests had been obtained, the data analysis techniques were initiated. These commenced with the normality test, followed by the homogeneity test, the hypothesis test, and the N-gain test.

RESULTS

In experimental class I, 32 students attended a learning using Problem Based Learning(PBL), while in the Experiment II class, 32 students learned using the Guided Inquiry learning model. At the end of the lesson, a posttest was administered in the two experimental classes to determine the learning outcomes of students who have been given treatment. The obtained student learning outcomes are illustrated in Figure 1.

At the beginning and end of the lesson, all participants were given interest questionnaires to evaluate their increasing interest after completing the learning. The aim of obtaining student interest in learning is to ascertain the extent to which student interest in learning increases when presented with several statements in the questionnaire. The obtained initial and final students learnig interest are presented in Figure 2. Figure 2 shows no differences in learning interest among students in experimental class I and experimental class II, following the application of the two different models. In detail, the average interest in learning for experimental class I students before applying the PBL model was 51.46, while the average final interest in learning after implementing the PBL model was 86.62. Meanwhile, the average in the experimental class II before the implementation of the guided inquiry model was 46.18 and the average posttest score was 82.46.

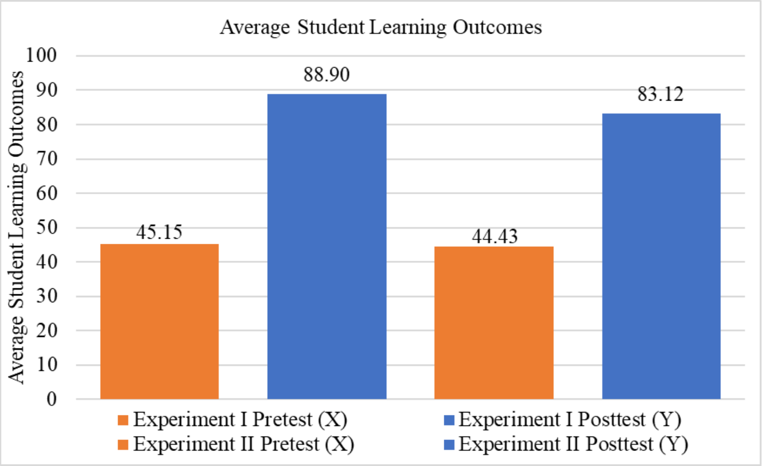

Figure 1. Average pretest and posttest scores of student learning outcomes

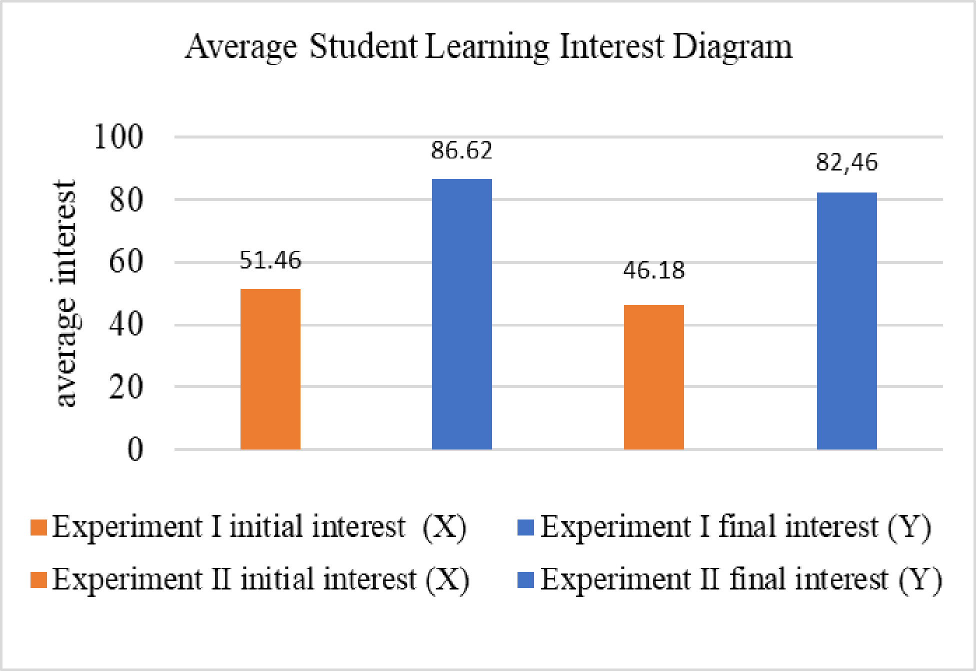

Figure 2. Average value of initial and final interest in student learning

Hypothesis test I student learning results

Hypothesis testing was carried out using a two-party t test to determine whether there were differences in learning outcomes between the two experimental classes or not. If $t_{count} > t_{table}$ then H_a is accepted and H_0 is rejected, with degrees of freedom (db) = n1+ n2−2 and α = 0.05. Hypothesis test result data can be seen in Table 2.

Table 2. Hypothesis test results on student learning outcomes

Class data		T_{count}	t_{tabel}	Information
Experiment I	Experiment II			
$\bar{x}_1$ = 88,90	$\bar{x}_2$ = 83,12			Ha accepted
S = 6,68	S = 8,95	2,133	1,999	
S2 = 44,73	S2 = 80,24			

Based on the hypothesis test, the t-count value was 2.133. The critical region at −t < −t ½ α and t > t ½ α where α = 0.05 then ½ α = 0.025, db = n1 + n2− 2 = 62. The obtained ttable= 1.999 with t ½ = 0.025 which can be seen in the t distribution table. Based on the t test calculation, the obtained tcount= 2.133, thereby the tcount is in the critical region, namely reject H) with $-t_{count} <$ – 1.999 or $t_{count} >$ 1.999. Accordingly, the H_0 was rejected and H_a was accepted.

Hypothesis Test II Student Interest in Learning

Hypothesis testing was carried out using a two-party t test to determine the presence of differences in learning outcomes between the two experimental classes. When $t_{count} > t_{table}$ then Ha is accepted and H_0 is rejected, with degrees of freedom (db) = n1+n2−2 and α = 0.05. Hypothesis test result data is summarized in Table 3.

Table 3. Hypothesis test results on student interest in learning

Class data		T_{count}	t_{table}	Information
Experiment I	Experiment II			
$\bar{x}_1 = 86,62$ S = 7,19 $S^2 = 51,72$	$\bar{x}_2 = 82,46$ S = 8,18 $S^2 = 67,03$	2,154	1,999	Ha accepted

Based on the hypothesis test results, the t-count value was 2.154. Two-party t test calculations in the appendix. The critical region at −t < −t ½ α and t > t ½ α where α = 0.05 then ½ α = 0.025, db = n1 + n2 − 2 = 62. Obtained t_{table}= 1.999 with t ½ = 0.025 which can be seen in the t distribution table. Based on the t test calculation, the obtained tcount= 2.154, thereby, the tcount is in the critical region, namely reject H with $-t_{count} < -1.999$ or $t_{count} > 1.999$. Therefore, the H_0 is rejected and Ha is accepted.

Hypothesis II Correlation Test

Hypothesis test II was performed using the correlation test through the Product Moments to determine the relationship between learning outcomes and student interest. The criterion in this test is $r_{count} > r_{table}$.

Table 4. Correlation test results of learning outcomes and student interests

Data	N	R_{acount}	r_{tabel}	Information
Experiment I	32	0,531	0,3494	Ha is accepted, H_0 is rejected
Experiment II	32	0,672		

Based on the results presented in Table 4, the correlation test results in experiment I are $r_{count} > r_{table}$(0.531 > 0.3494) and the correlation test results in experiment II are $r_{count} > r_{table}$ (0.672 > 0.3494) with db 30. Therefore, there is a positive correlation between student interest and learning outcomes.

N-Gain Test

Learning outcomes

The N-gain test was carried out to determine the increase in student learning outcomes from the two classes. Further, the increase was classified as high (g > 0.7), moderate (0.3 > g ≤ 0.7), low (g < 0.3). From the results of the gain calculations for the two samples, the average gain is presented in Table 5.

Table 5. N-Gain test results on student learning outcomes

Class	N-Gain		Criteria
	$\bar{x}$	%	
Experiment I	0,79	79,3	High
Experiment II	0,69	69,34	Medium

Table 5 shows that in experimental class I, a gain of 79.3% has been obtained, classified in high criteria, while in experimental class II the gain is 69.34%, in medium criteria. Therefore, the learning outcomes of students who have learned using the PBL model are higher than students who used the Guided Inquiry model.

Student Interests

The N-gain test was carried out to determine the increase in learning interest among students from two classes. The scores of students' learning interest were classified into high ($g > 0.7$), medium ($0.3 > g \leq 0.7$), low ($g < 0.3$). The obtained average gain for the two groups is presented in Table 6.

Table 6. N-Gain test results on student learning interest

Class	N-Gain		Criteria
	$\bar{x}$	%	
Experiment I	0,71	71,38	Medium
Experiment II	0,67	67,28	Medium

As presented in Table 6, experimental class I attained 71.38% gain in medium criteria, while in experimental class II, the gain was 67.28% with medium criteria. Thus, it can be concluded that students who are taught using the PBL model have higher learning interest than students who are taught using the guided inquiry model.

DISCCUSION

This study was conducted in January 2024 at State Senior High School 10 Medan, Indonesia, involving the eleven-grade science 2 and 4 during the academic year 2023/2024. For the academic year of 2023/2024, the research population consisted of students from eleven grade science class of State Senior High School 10 Medan, Indonesia. Purposive sampling was used to attain specific study goals from this population. Experimental class I (eleven science 2) was taught Problem Based Learning (PBL), while experimental class 2 (eleven science 4) learned Guided Inquiry. The study seeks to identify differences in learning results and student interest in acid base topics taught using the Problem Based Learning (PBL) and Guided Inquiry models, as well as the relationship between student interests and learning outcomes. Before learning started, two experimental classes were given a pretest. Then, they were asked to fill an introductory interest questionnaire to assess the outcomes and initial learning interests. The pretest consisted of 20 multiple choice questions that match the validation test's criteria for difficulty, distinction, and reliability. Following the pretest, students were given a questionnaire to assess their first enthusiasm in learning about chemistry. The learning interest questionnaire included 25 positive remarks evaluated by the chemistry lecturer.

The learning process in experiential learning class I was carried out using the PBL model. After the condition was met, students received a pretest and a questionnaire about their learning preferences. In this class, the acid material was taught using the PBL format. In the following stage, the class was divided into six groups of six students to explain the learning topic with acid base questions. Then, they were assigned a learner worksheet. After presenting their findings, they fulfil the student worksheet. The second meeting was scheduled for Friday, January 12, 2024, starting at 08.45 in experimental class I. Thereafter, the students had a break and the fourth lesson, which lasts until 10.30. Following orientation, the laboratory instructors guide the students through the next material on acids and bases with the students. Subsequently, the students engage in a learning worksheet, where they identify acid-base solutions practically using natural indicators. They then discuss the answers to the questions in the worksheet and present the results of their practicum. On Thursday, January 18, 2024, during the third experimental class, students engaged in a series of activities from 10:45 a.m. to 11:30 a.m. in Lessons 5 and 6. Prior to this, students were oriented to the acid-base material, after which they proceeded to identify solutions in a practical exercise. The students debated the answers to the questions in the student worksheet while discussing the use of false indicators in acid-base reactions. In the face of time constraints, the students presented their practicum outcomes. However, the lecturers extended the learning period by using break intervals to ensure that the learning was effective. Following the presentation, the instructor conducted a post-presentation examination as well as the initial learning interest questionnaire to determine whether the PBL model improved students' learning outcomes and interests

Class II attended learning using the Guided Inquiry model. Upon entering the class, an orientation period began, which included meeting classmates, praying, and taking notes of attendance. Once the condition was stable, a pretest and a questionnaire about students' interest in learning were administered. The acid material was then taught using the Guided Inquiry model. In the next stage, the class was divided into groups of six students , then the learning material was discussed by asking several questions about acids and bases. Subsequently, the students were given a worksheet and instructed to follow it. The results of the worksheet study were presented and discussed. Given the limited time available to complete the learning, a series of intermissions were applied to ensure that the learning objectives were met. This was done to assist pupils who were experiencing difficulties in completing the selections. The theory is based on the Guideline Inquiry syntax. Classes 1 and 2 will commence at 07:15-08:45 on Friday, January 12, 2024, at the second melting point. Upon returning to class, students are divided into groups and the instructor provides an overview of the next material on acids and bases. This was followed by a learning activity in which students apply their knowledge. The students performed a practicum on identifying acid-base solutions using natural indicators. Then, they discussed the answers to the worksheet questions and presented their practicum results. The third lecture in the Experimental Class II series was held at 8:45 a.m. on January 16, 2024. Subsequently, students were divided into groups and provided with instructions regarding acid-base solutions. The next stage of the programme involved a practicum where students were required to utilise artificial indicators to identify acid-base solutions and to engage in discussions regarding the responses to worksheet queries. Finally, due to time constraints, students were required to report their practicum outcomes. This was done by incorporating break intervals to enhance effective learning. Following the presentation, the researcher employed a posttest and the same learning interest questionnaire as the initial measurement to ascertain whether the Guided Inquiry Model Therapy enhanced students' learning outcomes and interests.

Following the three learning meetings, an analysis of student learning outcomes and interests was performed to explore the differences in student learning outcomes and interests as a result of implementing the PBL model in experimental class I and Guided Inquiry in experimental class II, as well as a correlation between learning outcomes and student interests. According to the data, students' average grade outcomes were 45.15 at the pretest and 88.90 at the posttest, while their average learning interest in experimental class I was 51.46 at the initial phase and 86.62 at the final stage. The average rise in student interest was 35.16%. This is congruent with Widyarsih's (2020) findings, which indicate that using the PBL learning paradigm improves acid-base content learning results from 55.2 to 72.5. According to Rislaepi et al., (2023) PBL has the potential to enhance students' interest and learning outcomes in chemistry. The level of interest exhibited by students increased from moderate (average of 2.79) to high (average of 3.61). The mean learning score increased from 73.45 to 87.37. The mean grade-level learning outcome is 44.43, with an average of 83.12. The average increase in learning outcomes was 38.75, while the initial enthusiasm for learning was 46.18, with a final score of 82.46. Consequently, the average learning outcome increased by 36.21. According to Anzani and Ismono's (2020) research findings, the use of the Guided Inquiry learning paradigm can improve learning outcomes, as indicated by the increasing average pretest-posttest scores from 44.05 to 91.43 and classical completeness from 0% to 96.43%. Further, the data on average learning results and student interests show that the problem based learning model outperformed the guided inquiry.

Rombe et al. (2022) discovered that the PBL learning paradigm is particularly effective in raising students' enthusiasm for learning, with an average rise in students' scores of more than 50%. This is consistent with earlier research, which shows that the PBL paradigm can improve student learning outcomes. The N-gain values for learning outcomes (79.3% in the high group) and interest in learning (71.38% in the medium category) suggest that the PBL promotes learning.

Yusuf (2019) proposes learning approaches that can stimulate students' intrinsic interest and attention while actively engaging them in the learning process, such as the guided inquiry model. The implementation of the guided inquiry learning method resulted in an increase in student learning outcomes by 93.33%. This is consistent with prior studies that have found that the inquiry paradigm improves student learning outcomes. The N-Gain for learning outcomes in exploratory class II was 69.3%, while learning interest in the medium category was 67.28%. This indicates the efficacy of the guided inquiry model in facilitating learning.

In hypothesis testing, a two-party t test was employed on hypothesis I which represented the learning outcomes and interests, with the constraint $t_{count} > t_{table}$. It shows that Ha is accepted whereas Ho is denied, showing that the PBL and Guided Inquiry techniques create distinct learning outcomes among students in learning acid-base content. Using the criterion $t_{count} > t_{table}$, the interest hypothesis has a t value of 2.15 > 1.999. This demonstrates that Ha was accepted while Ho was denied, implying that students learning acid base materials using the PBL and Guided Inquiry techniques had divergent learning objectives. The results of this research hypothesis are supported by several relevant previous studies. For instance, the research conducted by Ris et al., (2022), where the t value was obtained $t_{count} > t_{table}$ (4.972 > 2.00), where Ho was rejected and Ha wass accepted, implying the presence of variations in the learning results among students who use the problem based and guided inquiry learning models, with the problem-based approach being more valuable.

CONCLUSION

The results of the research indicate that there are notable differences in the learning outcomes and interests of students who are taught using the Problem-Based Learning (PBL) model and guided inquiry. The findings indicate that the Problem-Based Learning (PBL) model yielded higher average learning outcomes and N-Gain than the guided inquiry model. This suggests that the PBL model may be a more effective approach for facilitating learning. Students are more active in participating in learning, thinking, communicating, searching, and processing data using the PBL model, which provides a space for free thinking. Students are required to identify concepts and solutions related to the material presented by the teacher in order to complete the LKPD tasks. In addition to discrepancies in learning outcomes and student interest, there is a positive correlation between student interest and learning outcomes when learning is conducted using the PBL model and guided inquiry. This implies that high student interest leads to high learning outcomes. The findings of this study can be utilized as a foundation for the implementation of learning, allowing educators to carefully explore creative learning models that are appropriate for the learning process to be undertaken.

Author contributions

The authors made significant contributions to the study's conception and design. The authors were in charge of data analysis, interpretation, and discussion of results. The final manuscript was read and approved by the authors.

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Conflict of interest

The authors declare that there is no potential conflict of interest.

Data availability statement

All data are available from the authors.

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