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# Problem-Based Learning with Scaffolding: Enhancing Chemical Conceptual Understanding, Curiosity, Communication Skills, and Character

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**ABSTRACT**

**Purpose of the study:** This research aims to determine the comparison and influence of problem-based learning integrated with scaffolding on students' conceptual understanding, curiosity and communicative character.

**Methodology:** The type of research used in this research is quantitative with an experimental type with a posttest only control group design. The population in this study were all chemistry education students for the 2021/2022 academic year consisting of 4 classes. The sampling technique used was cluster random sampling so that the samples were class A, class B and class C, each consisting of 21 students. The data collection instrument used was a test instrument to determine students' understanding of concepts after carrying out the learning process using the method used, a curiosity character questionnaire and a communicative character questionnaire.

**Main Findings:** The results of this research are that there are differences and influences of the application of the integrated scaffolding problem-based learning model on students' conceptual understanding, curious character and communicative character.

**Novelty/Originality of this study:** Through this exploration, research reveals that the comparison between the use of Problem Based Learning and Scaffolding methods in the context of understanding chemical concepts not only strengthens academic competence, but also forms the character of students who are passionate about knowledge and communicate effectively.



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## 1. INTRODUCTION

Learning is essentially a process, namely the process of managing, organizing the environment around students in order to grow and encourage students to carry out the learning process [1]-[3]. Learning is basically a stage in the activities of lecturers and students in implementing a learning program, namely an activity plan that describes basic abilities and basic theories which contains in detail the allocation of time, indicators for achieving learning outcomes, and steps for learning activities for each subject. Good and effective learning will provide space and opportunities so that children can learn more actively and can explore knowledge through their abilities/potentials and this requires good and appropriate assistance/guidance from teachers/lecturers as educators and accompanied by professional wisdom [4]-[6]. One of the things that educators need help with is learning chemistry to understand concepts that cannot be seen in all processes in everyday life.

Learning chemistry is a learning material that is included in the group of natural sciences which is parallel to other natural sciences, namely physics, biology and astronomy. However, the facts show that currently studying chemistry is still less interesting for students. To improve this, it can be done by improving or changing the learning methods used by teachers to help students better understand the concepts of the material being taught. In a learning process at school, teachers/lecturers need a learning model that is used as a way of delivering learning material to students [7]-[9]. Experts develop learning models based on learning principles, psychological theories, sociology, systems analysis, or other supporting theories [10]-[12]. Good learning in the classroom can foster students' understanding of concepts and foster students' way of thinking [13]-[15]. Many learning models exist and can be applied in the learning process so that students can be more active in it [16]. One of them is a problem-based learning model.

Problem Based Learning is a learning method that is triggered by problems [17]-[20], which encourages students to learn and work together in groups to find solutions, think critically and analytically, be able to determine and use appropriate learning resources [21]-[23]. The use of a problem in real life or everyday life characterizes this learning model. Problem-based learning is carried out in small groups guided by a tutor who acts as a facilitator [24]. In this case the facilitator is a teacher or educator. The syntax of learning with problem-based learning is: (1) Orienting students to the problem, (2) Organizing students to learn, (3) Guiding individual or group investigations, (4) developing and presenting work results, (5) Analyzing and evaluating the solution process problem [25]-[27]. With these steps, students can understand chemistry learning material easily, especially by integrating the application of scaffolding into the problem-based learning process so that they are more independent in solving it.

Scaffolding can be interpreted as assistance provided by educators to students to solve a problem in the process of constructing learning materials independently [28]-[30]. So the scaffolding given to students can be in the form of instructions, warnings, encouragement, breaking down problems into learning steps, providing examples or other things to enable students to grow independently [31]. Scaffolding is often used to help students reach the upper limit of their zone of proximal development, where students may not necessarily receive the same scaffolding techniques. Educators who provide scaffolding must pay attention to gradually diagnosing what support students need to complete the tasks at hand sequentially with the right support and at the right time for each student or the entire class. Apart from that, one of the benefits of using scaffolding in problem based learning is the provision of a supportive learning environment, where students are free to ask questions, provide input and have colleagues who can support them in dealing with new material [32], [33]. In this case, students will be more active in the learning process and exceed the level of knowledge they have, so they can maximize learning outcomes.

Understanding concepts is a fundamental aspect in the teaching and learning process in various fields of study, including chemistry. It involves the student's ability to understand basic principles, the relationships between concepts, and their practical applications [34]. A solid understanding of concepts allows students to build sustainable knowledge and apply those concepts in different contexts, both inside and outside the classroom. In the context of chemistry, a good understanding of concepts is an important foundation for students to develop the analytical and problem-solving skills needed in experiments and research [35].

The character of curiosity is a trait that encourages individuals to seek new knowledge, solve problems, and dig deeper into a topic [36]-[38]. Students who have this character tend to be active in the learning process, ask relevant questions, and seek further information to deepen their understanding [39]-[41]. A strong sense of curiosity can be a driving force for students to further explore chemistry concepts, perform additional experiments, and develop a deep interest in the subject.

Communicative character involves the ability to convey ideas, opinions, and information clearly and effectively to others [42]. In a learning context, good communication skills enable students to share their knowledge, collaborate with classmates, and participate actively in discussions [43], [44]. In chemistry learning, strong communication skills play an important role in explaining complex concepts, conveying experimental results, and discussing the application of chemical theory in everyday life or in a broader scientific context.

Previous research conducted by Sari et al. [45] regarding the implementation of problem-based learning assisted by scaffolding. The difference between this research and previous research lies in the variables that will be assessed from the application of the model. Apart from that, research conducted by Asrial et al. [46] regarding the application of problem-based learning with scaffolding techniques. The difference between this research and previous research is the same as above, namely that it lies in the variables that will be assessed from the application of the model.

The novelty of this research is that through a holistic approach, this research explores the complex relationship between problem-based learning, the use of scaffolding techniques, and student character development in the context of understanding chemical concepts. The interesting findings of this research not only highlight the effectiveness of integrated learning methods in improving understanding of chemical concepts, but also reveal a significant impact on students' character development, especially in cultivating deep curiosity and improving their communicative abilities. This illustrates the potential for learning that not only produces strong academic understanding, but also forms individuals who are active, curious, and able to interact effectively in various situations.

This research was carried out because of the urgency of improving the quality of chemistry learning to be more effective and inclusive in reaching various types of learners. By paying attention to the complexity of chemical material which is often considered difficult for some students to understand, as well as the importance of character development in holistic education, this research makes a significant contribution to the world of education. Presenting a deeper understanding of how certain learning methods, such as Problem Based Learning with the use of Scaffolding, can influence not only understanding of chemistry concepts but also students' character, this research can pave the way towards more effective and powerful learning practices for academic and character growth students as a whole. Based on the background above, the aim of this research is to determine the comparison and influence of problem-based learning integrated with scaffolding on students' conceptual understanding, curiosity and communicative character.

## 2. RESEARCH METHOD

### 2.1. Research Design

Based on the research objectives, the method used in this research is a quantitative method. Quantitative research is an inductive, objective and scientific research method where the data obtained is in the form of numbers, or statements that are assessed and analyzed statistically [47], [48]. The purpose of quantitative research is to prove a theory which is then researched, and produce data which is discussed and concluded whether it is in accordance with existing theory or deviates from theory [49]. The advantage of this quantitative method is that it can test theory and practice based on previous articles to explain the causes between variables in the research. The research design used was an experiment with a posttest only control group design, namely a group design divided into an experimental group and a control group that was not randomly selected.

### 2.2. Population and Sample

The population in this study were all students who were actively participating in chemistry education in the 2021/2022 academic year. Sampling in this research was carried out using a cluster random sampling technique. In this cluster technique, randomization is carried out in groups (classes) rather than individually. The final destination of this cluster random sampling technique is the school or class [50]. Using the cluster sampling technique, the subjects used as the control class were class A and class C, while the experimental class was class B, each with 21 students, so the total sample was 63 students.

### 2.3. Data Collection Technique

The data collection technique used in this research is in the form of distributing questionnaires [51], [52]. The data collection instrument used was a test instrument to determine students' understanding of concepts after carrying out the learning process using the method used, a curiosity character questionnaire and a communicative character questionnaire. Where the questionnaire uses a Likert scale. The indicators for the concept understanding test instrument, the curiosity character questionnaire and the students' communicative character can be seen in the table below:

Table 1. Indicators of Concept Understanding Test Instruments, Curiosity Character Questionnaires and Students' Communicative Character

| Variable | Indicator | Statement Number |
|---|---|---|
| Student Response to the Learning Model | Level of student participation in learning | 1,2 |
| | The level of student involvement in class discussions | 3,4 |
| | Level of student understanding of learning material | 5,6 |
| | The level of student activity in carrying out the assignments or exercises given | 7,8 |
| Concept Understanding | Explanation ability | 9 |
| | Deployment capabilities | 10 |
| | Problem solving skill | 11 |
| | Argumentation ability | 12 |
| Curiosity | Active participation | 13 |
| | Frequency of asking | 14 |
| | Depth of questions | 15 |
| | Search initiative | 16 |

| | | |
|---|---|---|
| Communicative | Involvement in discussions | 17 |
| | Creativity in the Search for Solutions | 18 |
| | Ability to Convey Ideas | 19 |
| | Listening Ability | 20 |
| | Collaboration Ability | 21 |
| | Ability to Deliver Feedback | 22 |
| | Ability to Customize Language | 23 |
| | Number of Statements | 23 |

The categories of student response to the learning model, conceptual understanding instruments, curiosity character questionnaires and students' communicative character can be seen in the table below:

Table 2. Category of Concept Understanding Instruments, Curiosity Character Questionnaire and Student Communicative Character

| Variable | Category | Indicator Intervals |
|---|---|---|
| Student Response to the Learning Model | Very not good | 8.00 – 14.00 |
| | Not good | 14.10 – 20.00 |
| | Good | 20.10 – 26.00 |
| | Very good | 26.10- 32.00 |
| Concept Understanding | Very not good | 5.00 – 8.75 |
| | Not good | 8.86 – 12.50 |
| | Good | 12.60 – 16.25 |
| | Very good | 16.35 – 20.00 |
| Curiosity | Very not good | 5.00 – 8.75 |
| | Not good | 8.86 – 12.50 |
| | Good | 12.60 – 16.25 |
| | Very good | 16.35 – 20.00 |
| Communicative | Very not good | 5.00 – 8.75 |
| | Not good | 8.86 – 12.50 |
| | Good | 12.60 – 16.25 |
| | Very good | 16.35 – 20.00 |

### 2.4. Data Analysis Technique

The data analysis techniques used in this research are descriptive statistical analysis and inferential statistical analysis. Where in descriptive statistical analysis the researcher will look at the percentages in each existing category, apart from that, they will also look at the mean, median, max and min values for each class. The inferential statistical analysis carried out in this research is an assumption test in the form of a normality test, linearity test and homogeneity test. Meanwhile, the hypothesis test is in the form of a comparison test with a Tukey post hoc follow-up test and an influence test, namely a regression test. Data analysis in this research was assisted by SPSS version 26 software.

### 2.5. Research Procedure

This research began with the implementation of the learning process using an integrated problem based learning model with scaffolding. After that, students are asked to complete a test to determine students' understanding of concepts and then a questionnaire containing indicators to measure students' curiosity and communicative character. After the data was collected, the data was analyzed using descriptive statistics and inferential statistics in the form of hypothesis testing, namely the T-test and regression test. The procedures in this research can be seen in the following picture:

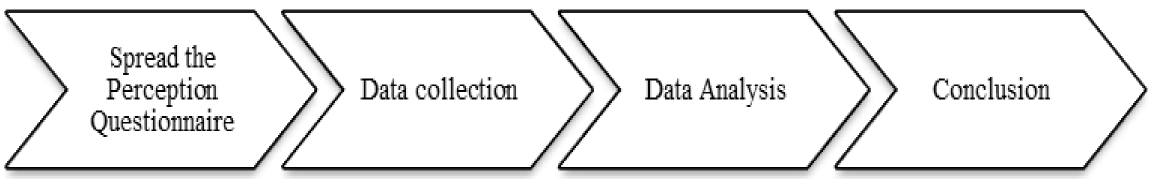


Figure 1. Research Procedure

## 3. RESULTS AND DISCUSSION

Based on the data obtained by researchers, the number of students in the control class and experimental class is shown in table 3 below:

Table 3. Research Design

| Respondent | Treatment | Postest |
|---|---|---|
| Control class (Class A) | Convensional | 21 |
| Control class (Class C) | Problem Based Learning | 21 |
| Experimental class (Class B) | Problem Based Learning with Scaffolding | 21 |

After creating an activity design by determining the control class and experimental class, descriptive statistical tests were carried out on the results of the distributed questionnaire which are presented in the following table:

Table 4. Descriptive statistics of student responses to the application of the learning model in control classes (A) and (C) and experimental class (B)

| Class | Category | Interval | F | % | Mean | Med | Min | Max |
|---|---|---|---|---|---|---|---|---|
| A | Very not good | 8.00 – 14.00 | 0 | 0 | 13.00 | 14.00 | 12.00 | 16.00 |
| | Not good | 14.10 – 20.00 | 2 | 9.52 | | | | |
| | Good | 20.10 – 26.00 | 8 | 38.09 | | | | |
| | Very Good | 26.10 – 32.00 | 11 | 52.38 | | | | |
| B | Very not good | 8.00 – 14.00 | 0 | 0 | 15.00 | 17.00 | 14.00 | 20.00 |
| | Not good | 14.10 – 20.00 | 0 | 0 | | | | |
| | Good | 20.10 – 26.00 | 2 | 9.52 | | | | |
| | Very Good | 26.10 – 32.00 | 19 | 90.47 | | | | |
| C | Very not good | 8.00 – 14.00 | 0 | 0 | 14.00 | 16.00 | 15.00 | 18.00 |
| | Not good | 14.10 – 20.00 | 0 | 0 | | | | |
| | Good | 20.10 – 26.00 | 15 | 71.42 | | | | |
| | Very Good | 26.10 – 32.00 | 6 | 28.57 | | | | |

Based on the results of descriptive statistical tests on student responses to the application of the learning model in control classes (A) and (C) and experimental class (B), it was found that the control class (A) was dominant in the very good category with a percentage of 52.38% for 11 people. Meanwhile, the control class (C) is dominant in the good category with a percentage of 71.42%. Meanwhile, the experimental class (B) was dominant in the very good category with a percentage of 90.47% as many as 19 people.

The descriptive statistics of students' conceptual understanding in control classes (A) and (C) and experimental class (B) can be seen in the table below:

Table. 5 Descriptive statistics of students' conceptual understanding in control classes (A) and (C) and experimental class (B)

| Class | Category | Interval | F | % | Mean | Med | Min | Max |
|---|---|---|---|---|---|---|---|---|
| A | Very not good | 5.00 – 8.75 | 0 | 0 | 14.00 | 16.00 | 13.00 | 17.00 |
| | Not good | 8.86 – 12.50 | 0 | 0 | | | | |
| | Good | 12.60 – 16.25 | 7 | 33.33 | | | | |
| | Very Good | 16.35 – 20.00 | 14 | 66.66 | | | | |
| B | Very not good | 5.00 – 8.75 | 0 | 0 | 15.00 | 18.00 | 15.00 | 20.00 |
| | Not good | 8.86 – 12.50 | 0 | 0 | | | | |
| | Good | 12.60 – 16.25 | 3 | 14.28 | | | | |
| | Very Good | 16.35 – 20.00 | 18 | 85.71 | | | | |
| C | Very not good | 5.00 – 8.75 | 0 | 0 | 14.00 | 17.00 | 13.00 | 19.00 |
| | Not good | 8.86 – 12.50 | 0 | 0 | | | | |
| | Good | 12.60 – 16.25 | 10 | 47.61 | | | | |
| | Very Good | 16.35 – 20.00 | 11 | 52.38 | | | | |

Based on the results of descriptive statistical tests on students' conceptual understanding in the control classes (A) and (C) and the experimental class (B), it was found that the control class (A) was dominant in the very good category with a percentage of 66.66% as many as 14 people. Meanwhile, the control class (C) is dominant in the very good category with a percentage of 52.38%. while the experimental class (B) was dominant in the very good category with a percentage of 85.71% as many as 18 people.

The descriptive statistics on the character of students' curiosity in control classes (A) and (C) and experimental class (B) can be seen in the table below:

Table 6. Descriptive statistics of students' curiosity characteristics in control classes (A) and (C) and experimental class (B)

| Class | Category | Interval | F | % | Mean | Med | Min | Max |
|---|---|---|---|---|---|---|---|---|
| A | Very not good | 5.00 – 8.75 | 0 | 0 | 13.00 | 15.00 | 14.00 | 17.00 |
| | Not good | 8.86 – 12.50 | 0 | 0 | | | | |
| | Good | 12.60 – 16.25 | 9 | 42.85 | | | | |
| | Very Good | 16.35 – 20.00 | 12 | 57.14 | | | | |
| B | Very not good | 5.00 – 8.75 | 0 | 0 | 15.00 | 17.00 | 18.00 | 20.00 |
| | Not good | 8.86 – 12.50 | 0 | 0 | | | | |
| | Good | 12.60 – 16.25 | 5 | 23.80 | | | | |
| | Very Good | 16.35 – 20.00 | 16 | 76.19 | | | | |
| C | Very not good | 5.00 – 8.75 | 0 | 0 | 13.00 | 15.00 | 14.00 | 18.00 |
| | Not good | 8.86 – 12.50 | 0 | 0 | | | | |
| | Good | 12.60 – 16.25 | 9 | 42.85 | | | | |
| | Very Good | 16.35 – 20.00 | 12 | 57.14 | | | | |

Based on the results of descriptive statistical tests on the character of students' curiosity in the control classes (A) and (C) and the experimental class (B), it was found that the control class (A) was dominant in the very good category with a percentage of 42.85% for 9 people. Meanwhile, the control class (C) is dominant in the very good category with a percentage of 57.14%, consisting of 12 people. Meanwhile, the experimental class (B) was dominant in the very good category with a percentage of 76.19%, as many as 16 people.

The descriptive statistics of students' communicative character in the control (A) and (C) and experimental classes (B) can be seen in the table below:

Table 7. Descriptive statistics of students' communicative character in control (A) and (C) and experimental class (B)

| Class | Category | Interval | F | % | Mean | Med | Min | Max |
|---|---|---|---|---|---|---|---|---|
| A | Very not good | 5.00 – 8.75 | 0 | 0 | 11.00 | 13.00 | 10.00 | 15.00 |
| | Not good | 8.86 – 12.50 | 5 | 23.80 | | | | |
| | Good | 12.60 – 16.25 | 10 | 47.61 | | | | |
| | Very Good | 16.35 – 20.00 | 6 | 28.57 | | | | |
| B | Very not good | 5.00 – 8.75 | 0 | 0 | 15.00 | 18.00 | 16.00 | 20.00 |
| | Not good | 8.86 – 12.50 | 0 | 0 | | | | |
| | Good | 12.60 – 16.25 | 5 | 23.80 | | | | |
| | Very Good | 16.35 – 20.00 | 16 | 76.19 | | | | |
| C | Very not good | 5.00 – 8.75 | 0 | 0 | 13.00 | 15.00 | 11.00 | 18.00 |
| | Not good | 8.86 – 12.50 | 0 | 0 | | | | |
| | Good | 12.60 – 16.25 | 15 | 71.42 | | | | |
| | Very Good | 16.35 – 20.00 | 6 | 28.57 | | | | |

Based on the results of descriptive statistical tests on the communicative character of students in the control (A) and (C) and experimental classes (B), it was found that the control class (A) was dominant in the good category with a percentage of 47.61% for 10 people. Meanwhile, the control class (C) is dominant in the good category with a percentage of 71.42%. Meanwhile, the experimental class (B) was dominant in the very good category with a percentage of 76.19%, as many as 16 people.

After carrying out descriptive statistical analysis, inferential statistical analysis is then carried out in the form of assumption tests and hypothesis tests. First, an assumption test is carried out in the form of a normality test, homogeneity test and linearity test. The results of the data normality test used in this research can be seen in the table below:

Table 8. Normality test of student response data regarding the application of learning models, understanding of concepts, curiosity and communicative character of students in control classes (A) and (C) and experimental class (B)

| Class | Variable | Statistic | df | Sig. | Distribution |
|---|---|---|---|---|---|
| A | Student response | .129 | 2 | .200 | Normal |
| | Concept Understanding | .106 | | .200 | Normal |
| | Curiosity | .119 | | .200 | Normal |
| | Communicative | .121 | | .200 | Normal |
| B | Student response | .115 | 21 | .200 | Normal |
| | Concept Understanding | .098 | | .200 | Normal |
| | Curiosity | .109 | | .200 | Normal |
| | Communicative | .129 | | .200 | Normal |
| C | Student response | .130 | 21 | .200 | Normal |
| | Concept Understanding | .127 | | .200 | Normal |
| | Curiosity | .115 | | .200 | Normal |
| | Communicative | .129 | | .200 | Normal |

Based on the results of the normality test of student response data on the application of the learning model, understanding of concepts, curiosity and communicative character of students in control classes (A) and (C) and experimental class (B), it was found that the significance value was greater than 0.05, namely 0.200 on all variables in both classes. So it can be concluded that the data on student responses to the application of the learning model, understanding of concepts, curiosity and communicative character of students in control classes (A) and (C) and experimental class (B) is normally distributed.

Next, a homogeneity test of student response data was carried out regarding the application of the learning model, understanding of concepts, curiosity and communicative character of students in control classes (A) and (C) and experimental class (B). The results of the test can be seen in the table below:

Table 9. Homogeneity test of student response data regarding the application of learning models, understanding of concepts, curiosity and communicative character of students in control classes (A) and (C) and experimental class (B)

| Class | Variable | N | Sig. | Distribution |
|---|---|---|---|---|
| A | Student response | 21 | .127 | Homogen |
| | Concept Understanding | | .071 | Homogen |
| | Curiosity | | .110 | Homogen |
| | Communicative | | .114 | Homogen |
| B | Student response | 21 | .132 | Homogen |
| | Concept Understanding | | .128 | Homogen |
| | Curiosity | | .182 | Homogen |
| | Communicative | | .112 | Homogen |
| C | Student response | 21 | .089 | Homogen |
| | Concept Understanding | | .099 | Homogen |
| | Curiosity | | .120 | Homogen |
| | Communicative | | .136 | Homogen |

Based on the results of the data homogeneity test of student response data on the application of the learning model, understanding of concepts, curiosity and communicative character of students in control classes (A) and (C) and experimental class (B), it was found that the significance value was greater than 0.05. So it can be concluded that the data on student responses to the application of the learning model, understanding of concepts, curiosity and communicative character of students in control classes (A) and (C) and experimental class (B) is homogeneously distributed.

After that, a linearity test of student response data was carried out regarding the application of the learning model, understanding of concepts, curiosity and communicative character of students in control classes (A) and (C) and experimental class (B). The results of this test can be seen in the table below:

Table 10. Data linearity test in control classes (A) and (C) and experimental class (B)

| Class | Variable | N | Sig. | Distribution |
|---|---|---|---|---|
| | Student Response*Concept Understanding | | .182 | Linear |
| A | Student Response*Curiosity | 21 | .168 | Linear |
| | Student Response*Communicative | | .163 | Linear |
| | Student Response*Concept Understanding | | .159 | Linear |
| B | Student Response*Curiosity | 21 | .122 | Linear |
| | Student Response*Communicative | | .148 | Linear |
| | Student Response*Concept Understanding | | .152 | Linear |
| C | Student Response*Curiosity | 21 | .175 | Linear |
| | Student Response*Communicative | | .189 | Linear |

Based on the results of the data homogeneity test of student response data on the application of the learning model, understanding of concepts, curiosity and communicative character of students in control classes (A) and (C) and experimental class (B), it was found that the significance value was greater than 0.05. So it can be concluded that the data on student responses to the application of the learning model with conceptual understanding, curiosity and communicative character of students in control classes (A) and (C) and experimental class (B) has a linear distribution.

After all the assumption tests are met, the research hypothesis is then tested. Where in this research we will carry out a comparison test with further post hoc Tukey tests and influence tests. The results of the comparison test in this research can be seen in the table below:

Table 11. Independent sample t-test results of student responses to the application of learning models, understanding of concepts, curiosity and communicative character of students

| Class | Variable | Sig. (2-tailed) |
|---|---|---|
| A<br>B<br>C | Student response | .032 |
| A<br>B<br>C | Concept understanding | .042 |
| A<br>B<br>C | Curiosity | .039 |
| A<br>B<br>C | Communicative | 0.35 |

Based on the results of the independent sample t-test, students' responses to the application of the learning model, understanding of concepts, curiosity and communicative character of students obtained a Sig. (2-tailed) is smaller than 0.05. So it can be concluded that there are differences in student responses to the application of the learning model, understanding of concepts, curiosity and communicative character of students in control classes (A) and (C) and experimental class (B). Because the results of the independent sample t-test show that there are differences, it can be continued with a further post hoc Tukey test. The results of the post hoc Tukey further test can be seen in the table below:

Table 12. Post Hoc Tukey test results

Multiple Comparisons

Dependent Variable: SR

| | (I) Class | (J) Class | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| | | | | | | Lower Bound | Upper Bound |
| Tukey HSD | A | B | -3.571 | 5.471 | .020 | -17.53 | 10.39 |
| | | C | -20.000* | 5.471 | .023 | -33.96 | -6.04 |
| | B | A | 3.571 | 5.471 | .023 | -10.93 | 17.53 |
| | | C | -16.429* | 5.471 | .005 | -30.32 | -2.74 |
| | C | B | 3.571 | 5.471 | .021 | -18.23 | 10.93 |
| | | A | -.16.429 | 5.471 | .005 | -20.63 | -5.56 |

*. The mean difference is significant at the 0.05 level.

Based on the results of the Tukey post hoc test, there were significant differences in student responses to the use of conventional learning models (A), problem based learning integrated scaffolding (B) and ordinary problem based learning (C). Between students who studied with the conventional learning model (A) and students who studied with the integrated scaffolding problem-based learning model (B), significant scores were obtained. 0.020 is less than 0.05, differences in student responses are also visible between students who study with the conventional learning model (A) and students who study with the ordinary problem based learning model (C) with a significance value of 0.023 less than 0.05. then for the responses of students who study with the integrated scaffolding problem based learning model (B) and students who study with the conventional learning model (A) there is also a difference with a significance value of 0.023 which is smaller than 0.05. Then for the responses of students who study with the integrated scaffolding problem based learning model (B) and students who study with the regular problem based learning model (C) there are also differences with a significance value of 0.005 which is smaller than 0.05. Furthermore, students who study with the usual problem based learning model (C) and students who study with the integrated scaffolding problem based learning model (B) also have differences with a significance value of 0.021 which is smaller than 0.05. while students who study with the usual problem based learning model (C) and students who study with the conventional learning model (A) have a difference with a significant value of 0.05, which is smaller than 0.05. Furthermore, the results of the Tukey post hoc test of conceptual understanding, curiosity and communication can be seen in the table below:

Table 13. Post Hoc Tukey test results

Tukey HSD[a,b]

| Variable | Class | School | Sig. |
|---|---|---|---|
| Concept understanding | A | B | 0.012 |
| | | C | 0.032 |
| Curiosity | A | B | 0.039 |
| | | C | 0.019 |
| Communicative | A | B | 0.035 |
| | | C | 0.047 |

Based on the results of the post hoc Tukey test above, the results show that there is a difference in understanding the concepts of students who study with the conventional model (A) and students who study with students who study with the scaffolding integrated problem based learning model (B) with a significance value of 0.012 which is smaller than 0.05, apart from that, there is also a difference in the conceptual understanding of students who study with the conventional model (A) and those who study with the regular problem based learning model (C) with a significance value of 0.032 which is smaller than 0.05. Furthermore, for students' curiosity, there is also a difference between students who study with the conventional model (A) and students who study with students who study with the scaffolding integrated problem based learning model (B) with a significance value of 0.039 which is smaller than 0.05, apart from that, There is a difference in the curiosity of students who study with the conventional model (A) and those who study with the regular problem based learning model (C) with a significance value of 0.019 which is smaller than 0.05. Meanwhile, for student communication, the results showed that there was a difference in understanding the concepts of students who studied with the conventional model (A) and students who studied with students who studied with the scaffolding integrated problem based learning model (B) with a significance value of 0.035 which was smaller than 0.05, apart from that There is also a difference in the conceptual understanding of students who study with the conventional model (A) and those who study with the regular problem based learning model (C) with a significance value of 0.047 which is smaller than 0.05.

Next, a test was carried out on the effect of applying the integrated scaffolding problem based learning model on students' conceptual understanding, curious character and students' communicative character, the results of which can be seen in the table below:

Table 14. The effect of implementing the problem based learning model integrated with scaffolding on students' conceptual understanding, students' curious character and communicative character.

| Variable | R | R Square | Sig. |
|---|---|---|---|
| Student response * Understanding of concepts | 0.854 | 0.73 | 0.03 |
| Student response * Curiosity | 0.883 | 0.78 | 0.02 |
| Student response * Communicative | 0.888 | 0.79 | 0.03 |

Based on the test results above, a decision can be made that there is an influence of the application of the integrated scaffolding probe-based learning model on students' conceptual understanding, namely an R

Square value of 0.73, which means that 73% of the application of the scaffolding-integrated probe-based learning model has an effect on students' conceptual understanding, then there is an influence The application of the integrated scaffolding probe-based learning model with students' curiosity, obtained an R Square value of 0.78, which means that 78% of the application of the scaffolding-integrated probe-based learning model has an effect on students' curiosity. Furthermore, there is an influence of the application of the integrated scaffolding probe-based learning model on student communicativeness, namely an R Square value of 0.79, which means that 79% of the application of the scaffolding-integrated probe-based learning model has an effect on student communicativeness. Based on the test results above, a decision can be made that there is an influence of the application of the integrated scaffolding problem based learning model on students' conceptual understanding, curious character and students' communicative character, this can be seen from the significance value < 0.05. The significance values obtained were 0.03, 0.02 and 0.03.

The application of the Problem Based Learning model integrated with the scaffolding approach has a significant impact on students' understanding of concepts. In this context, problem based learning allows students to engage in real problem solving, which triggers a deeper understanding of the subject matter [53]. Through a scaffolding approach, teachers can provide support appropriate to students' level of understanding, helping them build knowledge gradually [54]. This allows students to internalize the concepts taught and relate them to real-world situations, thereby increasing their overall understanding.

Not only does it influence understanding of concepts, the application of problem based learning integrated with scaffolding can also strengthen students' curious character. In the context of problem-based learning, students are naturally encouraged to find solutions to the problems they face [55]. A scaffolding approach ensures that students' curiosity is systematically guided, so that they can develop deeper research and exploration skills. This forms a critical and creative mindset, and fosters a spirit of exploration of new topics outside the classroom environment.

Apart from curiosity, the implementation of problem based learning integrated with scaffolding also has a positive impact on students' communicative character. In the problem solving process, students are invited to collaborate and discuss with each other. Through gradual support from teachers, students can develop effective communication skills, both in conveying ideas and listening to other people's opinions. This not only strengthens social relationships among students, but also improves their ability to convey thoughts and arguments in a clear and structured manner.

Previous research conducted by Ariyanti & Hermita [56] also discusses the problem based learning model integrated with scaffolding. The research found that the problem-based learning model integrated with scaffolding was able to increase students' understanding. The difference between this research and research currently being conducted is the subjects and variables to be measured.

Overall, the application of the problem based learning model integrated with scaffolding has a holistic impact on student development. In addition to improving conceptual understanding, this approach also strengthens students' curious and communicative character, forming a strong foundation for their future academic and social success. The novelty of this research is that this research provides a new contribution by showing that the application of the problem based learning model integrated with a scaffolding approach not only increases students' conceptual understanding, but also significantly strengthens their curious and communicative character. These findings reveal the great potential of a comprehensive learning approach in shaping students' thinking patterns and social skills.

Short-term impacts of this research finding may include improving the quality of classroom learning by increasing students' conceptual understanding and increasing social interaction and collaboration between students. Meanwhile, the long-term impact may include developing more holistic individual characteristics of students, such as increasing critical and creative thinking abilities and strong communication skills. In addition, these findings can also contribute to curriculum reform and more effective learning practices at various levels of education.

Although the findings of this study provide valuable insight into the impact of implementing a problem based learning model integrated with a scaffolding approach, several limitations need to be acknowledged. One is that the generalizability of findings may be limited to the specific context or particular sample used in the research. In addition, external factors such as differences in students' initial abilities or individual characteristics of teachers can also influence learning outcomes. Furthermore, long-term evaluation of the impact of learning on students is also an important consideration that needs to be integrated in future research.

## 4. CONCLUSION

Based on the hypothesis testing that has been carried out, it can be concluded that there are differences in student responses to the conventional model, problem based learning integrated with scaffolding and ordinary problem based learning. Apart from that, there are differences in students' conceptual understanding, curious character and communicative character in each learning model applied. Furthermore, there is an influence of the application of the integrated scaffolding problem based learning model on students' conceptual understanding, curious character and students' communicative character. Recommendations for further research are to conduct studies that involve a wider variety of contexts and representative samples, so that the results can be more generalized. In addition, expanding the scope of research to compare the effectiveness of problem based learning models integrated with scaffolding with other learning approaches will provide a more comprehensive understanding of the most effective learning methods. Future research is recommended to involve larger and more diverse samples from different educational levels and institutions to improve the generalizability of the findings. In addition, further studies should investigate the long-term effects of Problem-Based Learning with scaffolding on students' higher-order thinking skills, scientific communication, curiosity, and character development by employing longitudinal or mixed-method research designs.

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