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Strengthening the Concept of Data Presentation Through Scratch Media for Grade VII Students

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ABSTRACT

Mathematical conceptual understanding is one of the essential foundational competencies in mathematics learning, as it plays a crucial role in understanding more advanced materials. However, in reality, students' conceptual understanding is still below expectations. To address this issue, this research aims to determine the effect of using the Problem-Based Learning (PBL) model assisted by Scratch media on junior high school students' conceptual understanding of data presentation material. This research employed a quasi-experimental method with a one-group pretest-posttest design. The sample consisted of 27 seventh-grade students from a public junior high school in Bandung, selected through purposive sampling. The instruments used included essay tests and student satisfaction questionnaires. The results showed a significant increase in posttest scores compared to pretest scores, with the average rising from 56.59 to 82.37. The Wilcoxon test showed a significance value of < 0.001, indicating a statistically significant effect. Additionally, students provided positive feedback on the use of Scratch media, particularly in terms of visual appeal, language clarity, and increased motivation for learning. Therefore, the integration of the PBL model and Scratch has proven effective in enhancing students' conceptual understanding and providing meaningful learning experiences.

Kemampuan pemahaman konsep matematis merupakan salah satu kompetensi dasar yang penting dalam pembelajaran matematika karena menjadi dasar yang sangat penting untuk memahami materi-materi selanjutnya. Namun realitanya menunjukkan bahwa kemampuan pemahaman konsep matematis masih belum sesuai harapan. Untuk mengatasi permasalahan tersebut, penelitian ini bertujuan untuk mengetahui pengaruh penggunaan model pembelajaran Problem-Based Learning (PBL) berbantuan media Scratch terhadap kemampuan pemahaman konsep matematis siswa SMP pada materi penyajian data. Penelitian ini menggunakan metode quasi eksperimen dengan desain one-group pretest-posttest. Sampel penelitian ini adalah 27 siswa kelas VII di salah satu SMP Negeri di Kota Bandung yang dipilih menggunakan purposive sampling. Instrumen yang digunakan meliputi tes uraian dan angket kepuasan siswa. Hasil penelitian menunjukkan adanya peningkatan signifikan pada nilai postes dibandingkan pretes, dari rata-rata 56,59

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menjadi 82,37. Uji Wilcoxon menunjukkan nilai signifikansi < 0,001 yang mengindikasikan adanya pengaruh yang signifikan. Selain itu, siswa memberikan respon positif terhadap media Scratch, terutama dari segi tampilan visual, kemudahan bahasa, serta peningkatan motivasi belajar. Dengan demikian, integrasi model PBL dan Scratch terbukti efektif dalam meningkatkan pemahaman konsep dan pengalaman belajar yang bermakna bagi siswa.

A. INTRODUCTION

Education plays a crucial role in shaping a generation ready to face the complex challenges of the future. At the elementary level, one of the main challenges is students' low interest in mathematics, which is often perceived as complex and intimidating. This directly impacts students' poor understanding of mathematics materials. Chaerunnisa et al. (2021) revealed that low interest in learning is one of the factors contributing to students' poor conceptual understanding. Research by Kirana and Nur (2022) also confirmed that students with low interest in learning tend to have poor mathematical conceptual knowledge. Therefore, improving mathematical conceptual knowledge is a crucial aspect in efforts to improve the quality of mathematics learning.

The ability to understand mathematical concepts is one of the basic competencies that students need to master in mathematics learning. This ability reflects the extent to which students can understand mathematical ideas comprehensively and functionally, both in the classroom context and in everyday life (Kusnandar, 2022). Conceptual understanding is not only limited to memorizing formulas or procedures, but also includes the meaning of concepts, as well as the ability to relate them to other concepts. Students who can represent a mathematical idea in various forms, such as diagrams, symbols, or verbal models, demonstrate a good level of conceptual understanding (Kartika, 2018). Sengkey et al. (2023) formulated indicators of mathematical concept understanding ability which include: (1) restating a concept, (2) classifying objects based on specific properties, (3) providing examples and non-examples of a concept, (4) presenting concepts in various representations, (5) relating one concept to another, and (6) applying concepts in problem solving. These six indicators are crucial parameters in evaluating the extent to which students can think mathematically and conceptually.

However, several studies indicate that many students continue to struggle to connect mathematical concepts to everyday life. One of the leading causes is the abstract nature of mathematics and the minimal use of contextual learning approaches (Rahayu & Kusuma, 2019). Rahmah and Maarif (2021) identified that students often struggle to convert data from tables to pie charts due to a lack of understanding of the relationships between representations. Procedural errors, such as misreading scales or incorrectly converting values, also indicate poor conceptual understanding (Ningrum & Novtiar, 2023). However, a strong conceptual understanding is crucial, given that mathematical concepts are interrelated; errors in understanding one concept can lead to difficulties in understanding subsequent concepts

(Tresnawati et al., 2019). For example, in data presentation material at the junior high school level, errors in conceptual understanding can impact students' difficulties in learning more complex material at subsequent levels of education.

Field research indicates that mathematics learning, particularly in data presentation, continues to face various challenges. This material not only demands technical ability but also emphasizes students' interpretive abilities in reading and understanding quantitative information from the presented data (Lim et al., 2022). Pratiwi and Hakim (2023) stated that mathematical investigation ability, which includes the ability to present data, plays a crucial role in helping students understand the relationships between variables and perform deductive reasoning. Rahmah and Maarif (2021) again highlighted students' difficulties in converting data from tables to pie charts and in data processing. Frequent errors include incomplete data, unsystematic explanations, and errors in mathematical modeling and calculations (Ningrum & Novtiar, 2023). Christy and Panjaitan (2023) reported that only 43% of students were able to present data correctly in tabular form, while 59% made errors in creating bar charts. Research by Maghfiroh et al. (2020) also noted that students experienced difficulty converting percentage data to degrees when constructing pie charts. This situation suggests that meaningful learning experiences still need to be more intensively introduced in mathematics instruction. One potential approach to address this issue is the Problem-Based Learning (PBL) model.

Problem-Based Learning (PBL) is a learning model that links abstract concepts to real-world, contextual situations, strengthening students' understanding in solving everyday problems. Suwarma (2023) stated that PBL is efficacious in improving students' problem-solving ability because it actively engages them in the learning process. This model places problems as the starting point for learning and encourages exploration and teamwork in finding solutions (Junaid et al., 2021). According to Darwati and Purana (2021), the primary goal of PBL is not only to convey knowledge but also to develop critical thinking ability and independent problem-solving abilities through active learning. Ain et al. (2024) noted that integrating interactive media into PBL can enhance students' abilities in presenting data and thinking logically. With this approach, the learning process becomes more contextual, meaningful, and relevant to students' real-life experiences.

The effectiveness of PBL will be further enhanced with the support of appropriate digital media, one of which is Scratch, a visual programming language designed for user-friendliness in creating animations, simulations, and educational games (Suherman et al., 2023). Scratch is not only a programming tool but also an interactive learning medium that supports the understanding of mathematical concepts, including data presentation materials (Irawan et al., 2023; Fadila & Ramadhani, 2024; Al-Sindi et al., 2023). The use of Scratch in the context of PBL has been shown to increase active participation and students' problem-solving abilities (Fauziah et al., 2024). Chaerunnisa et al. (2021) also found that the application of Scratch in mathematics learning can significantly increase student engagement. Hafizah (2024) and Nurhaliza Ali and Lestari (2023) stated that the integration of Scratch in learning not only has a positive impact on learning outcomes but also can increase students' creativity and emotional engagement.

Scratch has been utilized in the development of learning media for various subjects, such as algebraic multiplication (Yulianisa & Sudihartinih, 2022) and in introducing the concept of artificial intelligence to adolescents (Darmawan et al., 2025), demonstrating its flexibility as an educational digital medium. Developed by the Massachusetts Institute of Technology (MIT), Scratch is designed to develop students' logical understanding and

reasoning through interactive play activities (Libryanti & Sudihartinih, 2023; Aulia et al., 2021). Scratch's user-friendly, block-based visual interface makes it highly suitable for beginner students to grasp concepts. Afrilianto et al. (2022) confirmed that the Scratch application has been proven valid, practical, and effective for use in education, including the development of student character. Therefore, Scratch can be seen as an alternative learning medium worthy of widespread implementation.

These conditions underscore the importance of developing learning solutions that are innovative, contextual, and responsive to students' needs. Scratch offers a dynamic visual approach to facilitate conceptual understanding, particularly in materials that require data visualization and analysis. Yulhendri (2022) stated that the use of audio-visual-based media such as Scratch can stimulate students' creativity and innovative thinking in understanding concepts constructively. Recent research has shown that the use of Scratch has been proven to increase learning interest (Fadila & Ramadhani, 2024), creative thinking ability (Nurhaliza Ali & Lestari, 2023), learning outcomes (Herdiansyah et al., 2023), and students' understanding of mathematical concepts (Fauziah et al., 2024). Maulana and Cahyono (2024) concluded that Scratch learning media have a positive impact on learning effectiveness, particularly in materials that require visual representation. Bitu et al. (2024) noted that student engagement in interactive learning fosters a deeper understanding of the material, particularly in conceptual topics such as data presentation.

Considering the various challenges and potentials that have been outlined, it is clear that a learning strategy that integrates the Problem-Based Learning (PBL) model with interactive media such as Scratch has the potential to be an effective alternative solution to improve students' understanding of mathematical concepts. This media allows students to construct and understand data representations in a visual, engaging, and contextual manner. However, although there have been many studies examining the application of the PBL model and the use of Scratch separately in mathematics learning, empirical studies that integrate the two to improve students' understanding of mathematical concepts in data presentation material at the junior high school level are still limited. Therefore, this study aims to examine the effect of using Scratch media in the PBL model on improving students' understanding of mathematical concepts in data presentation material in seventh grade junior high school.

B. METHODS

This research uses an experimental research design with a quantitative approach. The method used in this research is quasi-experimental, namely, the selection of subject groups is not entirely random due to limitations in the field. The design used in this research is a one-group pre-test-post-test design. The research was conducted on one group of subjects without a control group. The research aims to determine the effect of the Problem-Based Learning (PBL) learning model assisted by Scratch multimedia on students' conceptual understanding abilities in data presentation materials. Before the treatment was given, students first took a pre-test to measure their initial mathematical conceptual understanding abilities. Next, they were given treatment in the form of learning using the Scratch-assisted PBL model. After the treatment, students took a post-test to determine changes in their mathematical conceptual understanding abilities. In addition to the post-test, students were also given a questionnaire to assess their satisfaction with using Scratch multimedia. However, the absence of a control group is a limitation of this study, as this may limit the ability to attribute the observed changes exclusively to the learning model implemented.

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This research was conducted in the even semester of the 2024/2025 academic year at a public junior high school in Bandung City. The population in this research consisted of all seventh-grade students, while the research sample comprised one class of 27 students. The sampling technique used was purposive sampling, namely selecting samples based on specific considerations. In this case, classes were selected that had characteristics that met the research needs, such as time availability, teacher readiness, and suitability of the learning schedule. This technique was chosen to ensure that the implementation of the PBL model, assisted by Scratch multimedia, could be optimally implemented in a supportive classroom environment.

The instruments used in this research were categorized into two types: test instruments and non-test instruments. The test instrument used was a descriptive question on data presentation material, consisting of four questions whose validity had been tested by expert lecturers. Each question contained indicators of mathematical concept understanding abilities. The test was administered to students in the form of a Pretest and Posttest to evaluate the effectiveness of the treatment, specifically learning using the PBL model assisted by Scratch. The results of the Pretest were used to determine students' abilities before being given the treatment. At the same time, the Posttest was used to determine the effect of learning using the PBL model assisted by Scratch on students' mathematical concept understanding abilities. The non-test instrument used in this research was a questionnaire sheet about student satisfaction with the use of Scratch multimedia. The questionnaire consisted of positive and negative statements, with each question offering four alternative answers: strongly agree (SS), agree (S), disagree (TS), and strongly disagree (STS). The questionnaire was administered to students to assess the effectiveness of Scratch in the learning process.

Data in the form of scores from the pre-test and post-test will be analyzed with the Wilcoxon test using SPSS software. In contrast, data obtained from the student questionnaire will be converted using a Likert scale to measure the level of student satisfaction with the use of Scratch multimedia and determine its effectiveness during the learning process. Each positive statement in the questionnaire is valued at 4, 3, 2, and 1, respectively, for negative statements.

C. RESULTS AND DISCUSSION

Results

This section presents the results of the implementation of the Scratch-assisted Problem-Based Learning (PBL) model in improving students' conceptual understanding of mathematics in data presentation materials. These results are based on a comparison of students' pre-test and post-test scores, as well as students' responses to the use of Scratch multimedia during the learning process. The observed changes in students' conceptual understanding are consistent with constructivist learning theory and previous studies that emphasize the role of Problem-Based Learning and interactive multimedia in supporting students' conceptual understanding and engagement in mathematics learning. Based on the results of the pre-test and post-test administered to students, the data obtained are presented in Table 1 below.

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Table 1. The Results of Pretest and Posttest Data

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	27	20	72	56,59	11,174
Posttest	27	56	100	82,37	9,431
Valid N (listwise)	27				

The data listed in Table 1 are Pretest and Posttest data with a maximum value of 100 each. Based on Table 1, it is evident that the average post-test score is 25.78 points higher than the pre-test score. The difference in the average post-test and pre-test scores is quite significant, indicating that students' mathematical concept understanding ability after being given treatment in the form of learning with the Scratch-assisted PBL model is better than before being given treatment.

The pretest and posttest scores were also tested using SPSS software to determine the effect of the Problem-Based Learning (PBL) model with Scratch multimedia on students' conceptual understanding of data presentation. The Wilcoxon test was used because the data were from dependent groups. The hypotheses for this test are as follows.

$H_0: \mu_1 = \mu_2$ (There is no influence of the use of the Scratch-assisted PBL learning model on the ability to understand mathematical concepts of junior high school students in data presentation material)

$H_1: \mu_1 \neq \mu_2$ (There is an influence of the use of the Scratch-assisted PBL learning model on the ability to understand mathematical concepts of junior high school students in data presentation material)

The significance level used is 5% with the following testing criteria.

If the $Sig. \geq \alpha = 0{,}05$ then H_0 is accepted

If the $Sig. < \alpha = 0{,}05$ then H_0 is rejected

The results of the difference test analysis between the two averages are presented in Table 2 below.

Table 2. The Results of the Wilcoxon Test

	Posttest-Pretes
Z	-4,551
Asymp. Sig. (2-tailed)	<,001

Based on Table 2, the *Sig. (2-tailed)* < 0,001 < 0,05, so H_0 is rejected. This means that using the Scratch-assisted PBL learning model affects junior high school students' ability to understand mathematical concepts in data presentation materials.

Meanwhile, a questionnaire on student satisfaction with the use of Scratch multimedia generally showed perfect results. Based on these results, it was found that 100% of students fell into the 'agree' or 'strongly agree' category for the statement that the media display was clear, the language was easy to understand, and Scratch was able to increase their interest and motivation to learn. However, 32% of students reported that the background noise in the media was not audible. After conducting in-depth interviews, it was discovered that the background noise was not audible due to the fairly noisy classroom conditions, rather than a technical error with the media itself.

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Discussion

The data obtained from this research to determine the effect of using the Scratch-assisted PBL learning model on junior high school students' ability to understand mathematical concepts in data presentation material are the students' pre-test and post-test scores. The data obtained from the students' pre-test and post-test scores show that the average post-test score is higher than the pre-test score 25.78. The difference in the average post-test and pre-test scores is substantial, indicating that the ability of students to understand mathematical concepts after being given treatment in the form of learning with the Scratch-assisted PBL model is better than before receiving treatment. After conducting the Wilcoxon test using SPSS, the *Sig. (2-tailed)* < 0,001 < 0,05 with the decision H_0 being rejected, which suggests that the use of the Scratch-assisted PBL learning model has an impact on the ability of junior high school students to understand mathematical concepts in the context of data presentation. These results can be obtained because students are given learning using the Scratch-assisted PBL model.

The implementation of the student-centered PBL model enables students to be actively involved in the learning process, thereby strengthening their conceptual understanding of the material being studied. This finding aligns with the results of research by Marliana et al. (2023), which demonstrated that students' ability to understand mathematical concepts was better when they received learning through the PBL model compared to those who received direct instruction. In addition, Wibawa et al. (2023) stated that the use of the PBL model affected students' understanding of mathematical concepts, as the stages in the PBL model provided opportunities to enhance students' understanding of these concepts. The results of research by Sabar et al. (2023) also showed that the PBL model was more effective than the direct learning model on students' understanding of mathematical concepts.

In this research, the use of interactive learning media, specifically Scratch, serves as a medium to strengthen students' conceptual understanding of the material being studied. Students who learn using Scratch find it easier to understand concepts because they can see data visualizations directly and interactively, making the thinking process more concrete and enjoyable. Based on the research's results, it was found that 100% of students fell into the 'agree' and 'strongly agree' categories for the statement that the media display is clear, the language is easy to understand, and Scratch can increase interest and motivation in learning. Thus, Scratch is effective in strengthening students' understanding of mathematical concepts. This finding aligns with the results of research by Ningrum and Novtiar (2023), which demonstrated a significant improvement in student learning outcomes between the pre- and post-Scratch learning media use. This can occur because students are more enthusiastic when the material being studied is presented using Scratch, which is an interactive and engaging platform.

This research combines the PBL model with Scratch media, resulting in an impact of the use of the Scratch-assisted PBL learning model on junior high school students' mathematical conceptual understanding of data presentation. This finding aligns with research by Aulia et al. (2024), which demonstrated that the use of the PBL model with Scratch media can improve learning outcomes.

D. CONCLUSION

Based on the research results, strengthening the concept of data presentation using Scratch media yielded positive results. The use of the Scratch-assisted PBL learning model

had a significant impact on junior high school students' mathematical conceptual understanding of data presentation. This approach not only improved conceptual understanding but also increased student interest and motivation in learning. Interactive data visualization through Scratch helped students understand the material in a concrete and enjoyable way, creating a more effective learning experience.

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