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Effect of Conceptual, Understanding, Procedural, and Problem-Based Learning Models Using a Contextual Approach on Students' Conceptual Understanding Skills

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ABSTRACT

Mathematical conceptual understanding is one of the key competencies that students must possess in mathematics learning, as it enables them to connect concepts, explain procedures, and apply mathematical knowledge in various problem-solving situations. However, in classroom practice, students' mathematical conceptual understanding remains relatively low, indicating the need for instructional models that can facilitate more meaningful learning. This study was motivated by the low level of mathematical conceptual understanding among seventh-grade students at SMP Negeri 7 Muaro Jambi. It aimed to determine whether the Conceptual Understanding Procedures (CUPs) learning model with a contextual approach and Problem-Based Learning (PBL) with a contextual approach influenced the mathematical conceptual understanding of seventh-grade students at SMP Negeri 7 Muaro Jambi in the 2025/2026 academic year. This study employed a quantitative approach with a quasi-experimental method using a pretest-posttest control group design. The population consisted of all seventh-grade students at SMP Negeri 7 Muaro Jambi during the 2025/2026 academic year, and the sample was selected through simple random sampling. The research instruments included a test of students' mathematical conceptual understanding and an observation sheet used to assess the implementation of the learning process. The test was administered before and after the instructional treatment. Based on the N-gain analysis followed by a one-way ANOVA, the findings revealed a significant difference in the effects of the CUPs and PBL models with a contextual approach on students' mathematical conceptual understanding. Further analysis showed that students taught using the CUPs and PBL models achieved significantly different mean scores in mathematical conceptual understanding compared with those taught using the Direct Instruction model.

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Introduction

Mathematics is a important foundation in education that continues to evolve over time. According to Simanjuntak (2021) the importance of mathematics in daily life has led to the development of mathematics education and its adaptation to the needs of Indonesia. As members of the younger generation, every student requires mathematical knowledge tailored to their specific needs. Adaptive and contextual learning approaches are increasingly emphasized to enhance students' understanding. Therefore, teachers must continuously develop innovative teaching methods to align with these developments. Mathematics instruction utilizing various teaching tools can facilitate teachers' teaching and learning activities. Mathematics education is not merely focused on the final outcome but places greater emphasis on all activities within the ongoing teaching and learning process. Thus, it is hoped that all students will be able to solve mathematical problems but must also be able to understand the material and interpret it in daily life (Khusna & Ulfah, 2021). Each teacher designs teaching modules suitable for each session so that the learning objectives in mathematics can be achieved.

Mathematics must be taught in a sequential and continuous manner. Concepts should be taught in order, starting from the easiest to understand and progressing to the most complex (Winata & Friantini, 2022). In mathematics education, proficiency is an essential skill that students must master. One such proficiency in learning mathematics is conceptual understanding, which enables the achievement of learning objectives. With the ability to understand concepts, students can solve mathematical problems in accordance with mathematical concepts. In problem-solving, students will need rules aligned with existing concepts (Nurani et al., 2021). Conceptual understanding is formed independently by students; it cannot be achieved solely through the transfer of knowledge. The importance of conceptual understanding in mathematics is outlined in the National Standards issued. One of the competencies students must possess is understanding mathematical concepts, recognizing relationships between concepts, and applying these concepts to solve problems. Therefore, mastery of concepts must be the primary focus so that students have the foundational knowledge required to develop other skills such as reasoning, communication, making connections, and problem-solving.

Students who are able to discover concepts independently are far better able to understand and retain concepts in their memory for a long period of time (Radiusman, 2020). According to the National Council of Teachers of Mathematics (NCTM) and Harefa et al. (2022) indicators of conceptual understanding include defining concepts verbally and in writing, identifying and providing examples and counterexamples, using models, diagrams, and symbols to represent a concept, transforming one form of representation into another, recognizing various meanings and interpretations of a concept, identifying the properties of a concept and recognizing the conditions that define it, and distinguishing between concepts. These indicators can serve as effective assessment tools to evaluate the extent of students' conceptual understanding, thereby determining whether their level of conceptual understanding is low or adequate.

The low level of mathematical concept comprehension among seventh-grade students at SMPN 7 Muaro Jambi is evident from the results of a concept comprehension test completed by one of the students. Figure 1 shows that the student did not meet the indicator of restating a concept. The student arrived at the answer using an incorrect procedure. The student also did not meet the indicator of classifying objects according to specific properties in accordance with the concept. The student did not follow the instructions and immediately provided an answer without clear calculations. The student did not meet the indicator of presenting concepts in

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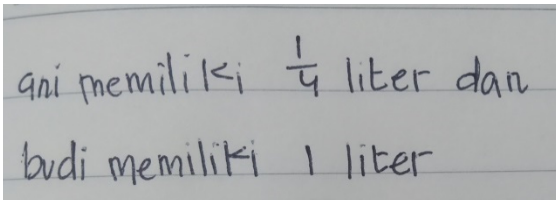
various forms of mathematical representation. The student provided a numerical answer that was close to correct.



"Ani has 1/4 liter and Budi has 1 liter."

Figure 1. Students' Answers to Mathematics Problems

Based on the results of the mathematical concept comprehension test, it appears that students' conceptual understanding remains relatively low. Teachers must play a role in helping to address this low level of mathematical concept comprehension among students (Buyung et al., 2022). One aspect of teacher involvement that can influence learning is the selection of instructional models, given that students' answers indicate their understanding is not yet fully accurate. Teachers still use conventional learning models. This aligns with Meilawati (2020) who states that one of the factors influencing students' conceptual understanding is the teacher's teaching strategies, which include learning models, strategies, approaches, and methods.

In this context, one strategy that can be implemented is to adopt a learning model that views students as individuals capable of self-development. The Conceptual-Understanding-Procedural (CUP) and Problem-Based Learning (PBL) models are rooted in constructivist learning theories, which view students as individuals capable of self-development. The constructivist-based approach is the contextual approach (Muhartini et al., 2023). Thus, the researcher employed the Conceptual Understanding and Procedural (CUP) and Problem-Based Learning (PBL) models in this study. The Conceptual Understanding and Procedural (CUP) learning model is an instructional approach that emphasizes students' ability to draw conclusions about the material they have learned using their own words. The CUP learning process encourages students to think actively and change their perspectives, thereby fostering active participation. According to Susanty et al. (2023) applying the Conceptual Understanding-Procedural (CUP) learning model in mathematics instruction can build students' understanding of the subject matter being studied.

In addition to Conceptual-Procedural Understanding (CUP), Problem-Based Learning (PBL) can also serve as a solution for teachers. PBL is a learning model in which students are presented with a real-world problem as a context for learning concepts (Ardianti et al., 2021). Learning using the PBL model makes the learning process student-centered and begins with a contextual problem, thereby encouraging students to understand concepts through the problem-solving process. The contextual approach focuses on problems related to real life and enables students to connect learning materials with real-life situations (Hrp et al., 2024). This aligns with the view of Siregar et al., (2020), who state that the approach capable of challenging students to understand concepts is the contextual approach. The contextual approach also involves problems relevant to students' daily lives-specifically within the scope of their personal experiences-enabling them to learn effectively. Thus, learning through the contextual approach can address students' low conceptual understanding.

There is a connection between the Conceptual Understanding Procedural (CUP) learning model and Problem-Based Learning (PBL) in addressing low conceptual understanding: CUP focuses on student activities in constructing their own knowledge through interaction and group discussions, while PBL focuses on real-life problems. Additionally, a contextual approach that focuses on real-world problems makes it much easier for students to understand the learning material. The Conceptual Understanding Prosedural (CUP) learning model is designed to actively engage students in interacting with teachers and one another. According to Kamariyah & Budiyono (2020), Problem Based Learning (PBL) demonstrates that PBL effectively hones students' comprehension skills, thereby addressing students' low conceptual understanding of the material being studied. Learning through experiences or elements found in daily life is easier to understand, as seen in the contextual approach, and thus helps students achieve a better understanding.

Based on the research by Masnia & Amir (2019) it was found that students' low ability to understand mathematical concepts is influenced by several factors, namely a teacher-centered learning system, students' lack of understanding of (formulas, properties, and problems) in solving mathematical problems, and students' inability to solve problems presented in different formats. On average, students rely solely on memorizing formulas; when presented with a problem or a context that differs from what was discussed, they encounter difficulties (Dewanti & Komala, 2023). This is consistent with the research by Kirana et al. (2022) which states that most students rely solely on memorizing formulas, and when presented with different problems, they immediately find it difficult to solve them. From these research findings, it can be concluded that students' ability to understand mathematical concepts is classified as low, and solutions must be sought to help them grasp the mathematical material during the learning process.

Method

Type of Research

The method used in this study is quasi-experimental research. The study design is a pretest-posttest control group design, in which there are experimental and control groups that will take a pretest at the beginning of the session and a posttest at the end of the session.

Table 1. Research Design

Class	Pretest	Treatment	Postest
Exsperiment I	O_1	X_1	O_2
Exsperiment II	O_3	X_2	O_4
Control	O_5	-	O_6

Population and Sample

The population is the total number of research subjects that possess the characteristics of the study and are the focus of the researcher's attention (Suriani et al., 2023). The population is not merely the total number of research subjects but encompasses all characteristics present in the research subjects. The population used in this study consists of all seventh-grade students at SMP Negeri 7 Muaro Jambi for the 2025/2026 academic year. In this study, a sample of three classes was used, consisting of two experimental classes Experimental Class I, which was treated with the Conceptual Understanding Procedural (CUP) learning model using a contextual approach, and Experimental Class II, which was treated with the Problem-Based Learning (PBL) model using a contextual approach as well as one control class using the Direct Instruction model. The sample should reflect all characteristics of the population; thus, the sample will be able to represent the population.

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Instrument

In this study, the research instruments used included an observation sheet for evaluating teachers' activities during instruction and assessing student activities, as well as tests of students' mathematical concept comprehension in the form of pretests and posttests on the topic of rational numbers, as in Table 2.

Table 2. Pretest and Posttest Questions on Mathematical Conceptual Understanding

Pretest Question
Ani bougth 3 pencils for $\frac{2}{5}$ of her allowance which totals $Rp50.000$ and 2 books for $\frac{3}{4}$ dari the money left after buying the pencils; she saved the rest for snacks tomorrow. Explain step by step how many rupiah Ani spent on the pencils and books, how much money she has left, and state all results in their simplest rational form while explaining why these fractions are rational numbers and how to compare the amount Ani spent on pencils with that on books?
Posttest Question
Rina ordered one large pizza and divided it equally among her 5 friends, but she ate only $\frac{3}{10}$ of her own slice and gave $\frac{2}{3}$ of the remaining portion to her younger sibling; the rest was eaten together. Explain in detail how much of the pizza Rina ate herself, how much she gave to her younger sibling, and how much was left over. Express all of this in the simplest form of rational numbers, and explain why these fractions are rational numbers, as well as how to compare the size of the portion Rina ate with that of her younger sibling.

Data Collection

Data collection in this study was conducted through observation, the use of observation sheets to assess the implementation of instruction by teachers and students, and the administration of essay tests to students as pretests and posttests. The data collection techniques used in this study are as follows:

Lesson Implementation Observation Sheet.

There are two types of lesson implementation observation sheets. The first is a lesson implementation observation sheet for teachers, and the second is a lesson implementation observation sheet for students.

Teacher's Lesson Implementation Observation Sheet.

The teacher's lesson implementation observation sheet is necessary for data collection to assess teachers' activities in implementing lessons in the experimental and control classes. This observation sheet serves as an evaluation of lesson implementation and a tool for teacher reflection. The teacher's lesson implementation observation sheet is completed by an observer during the lesson by checking the appropriate boxes in the statement columns. The checkmarks are marked according to the assessment, namely whether the activity was carried out or not.

Student Lesson Implementation Observation Sheet.

The student learning observation sheet is designed to monitor student activities during instruction in the experimental and control classes. The student learning observation sheet is completed during the lesson by checking the appropriate box in the statement column. The checkmark is placed based on whether the activity was carried out or not.

Student Conceptual Understanding Test

The outline for the test of students' conceptual understanding is as follows:

Table 3. Student Conceptual Understanding Assessment Guidelines

Learning Objectives	Learning Objectives	Concept Comprehension Indicators	Question Format	Question number
Students can apply arithmetic operations to rational numbers and provide estimates when solving problems (including those related to financial literacy).	Identify numbers that are rational numbers. Express rational numbers as fractions and decimals. Estimate the values of rational numbers. Compare rational numbers. Estimate the results of arithmetic operations involving rational numbers.	• Defining concepts verbally and in writing. • Identifying and providing examples and non-examples. • Using models, diagrams, and symbols to represent a concept. • Converting one form of representation into another. • Recognizing various meanings and interpretations of a concept. • Identifying the properties of a concept and recognizing the conditions that define a concept, and • Distinguishing between concepts.	Description	1

Data Analysis

Before conducting the ANOVA analysis, this study first met the prerequisite tests, namely the normality test and the homogeneity test. The normality test was performed using the Kolmogorov-Smirnov method via SPSS. The data were entered into SPSS in the Data View window, then analyzed via the Analyze, Descriptive Statistics, and Explore menus. Variables were moved to the Dependent List, and under the Plot section, Normality plots with tests were selected (along with a histogram if necessary). The results of the normality test were then interpreted based on the significance value: data were considered normally distributed if the Sig. value was greater than 0.05, and considered non-normal if the Sig. value was less than or equal to 0.05. After normality is confirmed, this study proceeds to a homogeneity test to ensure equal variance across groups. The homogeneity test is used to determine whether the population variances across several data groups are relatively equal, and this test is performed when the data meet the assumption of normality.

Once the normality and homogeneity assumptions were met, this study used a one-way ANOVA to determine whether there were differences in means among the treatment groups. The test decision was based on a comparison of the calculated F-value and the critical F-value: H_0 was accepted if the calculated F-value was equal to or less than the critical F-value, while H_0 was rejected if the calculated F-value was greater than the critical F-value. Additionally, the reference Nainggolan et al. (2025) explains that a one-way ANOVA can be understood by comparing the variance between groups with the variance within groups, where the variance within groups is also referred to as the error variance. In practice using SPSS, the steps for a one-way ANOVA are performed by entering variables into the Variable View and Data View, then selecting Analyze, Compare Means, and One-Way ANOVA. The outcome variable is entered into the Dependent List, while the group variable is entered into the Factor. If the ANOVA results indicate a significant difference, this study proceeds with post hoc tests to determine which pairs of groups differ. This aligns with Susilawati et al., (2024) who emphasize

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the importance of post hoc tests when ANOVA indicates significant differences. According to Dewi et al., (2023), the Post Hoc Test output helps identify groups with the same or different means. In this study, the Tukey test was used to compare all pairs of means after the analysis of variance was conducted. The Tukey test procedure was performed via the Post Hoc button in the One-Way ANOVA menu, selecting Tukey, and then enabling the Descriptive and Homogeneity of Variance Test options. The conclusion of the Tukey test was determined based on the significance level: if the significance level was less than or equal to 0.05, a significant difference was present; if it was greater than 0.05, no significant difference was present.

Research Findings

Observation sheets were used to assess the teacher's effectiveness in teaching and the alignment with the CUP model's syntactic stages. Based on the collected data, it was found that every learning activity conducted by the teacher went very well, as shown in Table 4. The implementation of learning by the teacher from sessions 1 to 4 in the classroom had an implementation percentage of $85\% - 100\%$ meaning that the implementation of learning in the CUP model was carried out very well.

Table 4. Percentage of Instructional Implementation by Teachers in the CUP Model with a Contextual Approach

Description	Meeting			
	1	**2**	**3**	**4**
Implementation rate (%)	85	95	95	100
Interpretation	Very good	Very good	Very good	Very good

In addition, the observational data indicate that student engagement in the CUP model activities during the four class sessions fell within the $80\% - 90\%$ range, meaning that student participation in the CUP model activities was very high, as in Table 5.

Table 5. Percentage of Student Learning Achievement in the CUP Model with a Contextual Approach

Description	Meeting			
	1	**2**	**3**	**4**
Implementation rate (%)	85	95	95	100
Interpretation	Very good	Very good	Very good	Very good

Data collected from observations of PBL-based learning using a contextual approach indicate that teachers conducted learning activities very effectively. The results are presented in Table 6 showing that the implementation of learning ranged from $93{,}33\% - 100\%$ indicating that PBL classroom instruction was carried out very effectively.

Table 6. Percentage of Instructional Implementation by Teachers in the Contextual PBL Model

Description	Meeting			
	1	**2**	**3**	**4**
Implementation rate (%)	96,66	93,33	96,66	100
Interpretion	Verry good	Verry good	Verry good	Verry good

In addition, Table 7 presents a dataset of observations regarding the implementation of student activities in PBL classes using a contextual approach over four sessions. The data falls within the $80\% - 90\%$ range, indicating that student activities in the PBL classes were carried out effectively.

Table 7. Percentage of Student Learning Achievement in the Contextual PBL Mode

Description	Meeting			
	1	**2**	**3**	**4**
Implementation rate (%)	80	83,33	90	83,33
Interpretion	Verry good	Verry good	Verry good	Verry good

The data for the control class are summarized in Table 8, The results of observations of the teachers' implementation of instruction from sessions 1 through 4 showed a percentage range of $89{,}47\% - 100\%$ indicating that the implementation of instruction in the Direct Instruction class was carried out very well.

Table 8. Percentage of Instructional Implementation by Teachers in the Direct Instruction Model

Description	Meeting			
	1	**2**	**3**	**4**
Implementation rate (%)	80	83,33	90	83,33
Interpretion	Verry good	Verry good	Verry good	Verry good

Finally Table 9, presents a summary of the observational data on student activity performance during lessons using the Direct Instruction model from Session 1 through Session 4, which ranged from $78{,}94\% - 94{,}73\%$ indicating that student activity performance in the control class achieved very good average results.

Table 9. Percentage of Student Learning Achievement in the Direct Instruction Model

Description	Meeting			
	1	**2**	**3**	**4**
Implementation rate (%)	84,21	78,94	89,47	94,73
Interpretion	Verry good	Good	Verry good	Verry good

Mathematical Concept Understanding Test Data

To examine the effects of the CUP, PBL, and DI models, tests of students' mathematical conceptual understanding were conducted involving Experimental Class I, Experimental Class II, and the control class. The purpose of presenting the descriptive data is to illustrate the differences in students' test scores before and after the implementation of the CUP, PBL, and DI models, as shown in Table 10.

Table 10. Descriptive Statistics

Class	Type of Test	Mean	N	Standart Deviation	Minimum	Maxsimum
Experimental Class 1	Pretest	11,181	32	1,518	5	18
	Posttest	18,781	32	5,386	10	27
Experimental Class II	Pretest	10,218	32	1,879	6	14
	Posttest	20,906	32	4,237	12	27
Control Class	Pretest	9,218	32	1,979	6	13
	Posttest	13,687	32	2,889	10	19

Table 10 presents the N-Gain Score data obtained from the analysis of test scores on the pretest and posttest for the three classes CUP, PBL, and DI, namely Experimental Class I, Experimental Class II, and the control class.

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Table 11. N-Gain Score

Class	Minimum	Maxsimum	Mean
Exsperimental Class 1	21.05	90.00	63,5454
Exsperimental Class II	15.79	92.86	60,3109
Control Class	.00	59.09	23,1223

Table 12 shows that the p-values for Experimental Class I, Experimental Class II, and the control group are $0{,}200; 0{,}200; 0{,}054$ respectively; thus, the p-values for all three sample groups are $\geq 0{,}05$. Based on the results of this data analysis H_0 is accepted, indicating that the mathematical concept comprehension test scores for the sample groups are normally distributed.

Table 12. Results of the Normality Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Experimental_Class_I	.106	32	.200	.938	32	.067
Experimental_Class _II	.087	32	.200	.939	32	.069
Control_Class	.153	32	.054	.940	32	.075

Table 13 shows that the significance value obtained is $0{,}095 \geq 0{,}05$ therefore H_0 is accepted. In other words, the data on mathematical concept comprehension test scores exhibit homogeneous variance.

Table 13. Results of the Homogeniety Test

		Levene Statistic	df1	df2	Sig.
NGain Score	Based on Mean	1.404	2	93	.251
	Based on Median	1.455	2	93	.239
	Based on Median and with adjusted df	1.455	2	90.247	.239
	Based on Trimmed Mean	1.411	2	93	.249

Since the prerequisite tests have been met, we proceed to test the hypotheses using a one-way ANOVA. The following are the results of the hypothesis testing analysis using a one-way ANOVA on Table 14.

Table 14. Results of the One-Way ANOVA test

ANOVA

Mathematical Conceptual Understanding Test

	Sum of Statistic	df	Mean Square	F	Sig.
Between Groups	3.229	2	1.615	40.726	.000
Within Groups	3.687	93	.040		
Total	6.916	95			

Table 14 above, the significance value of the one-way ANOVA test is 0,00 > 0,05 which means that H_0 is rejected and H_1 is accepted. A descriptive conclusion is drawn: the means of the three instructional models studied differ significantly. This indicates that the students' mathematical conceptual understanding is influenced by the CUP model with Contextual, the PBL model with Contextual, and the Direct Instruction model.

A Tukey test was conducted to identify significant differences among the three learning models, as shown in Table 15. It was found that the significance value for Experimental Class I—the application of the CUP model with a contextual approach and Experimental Class II—the application of the PBL model with a contextual approach was $0{,}285 > 0{,}05$ thus, the application of the CUP model with a contextual approach and the PBL model with a contextual approach are equivalent. Descriptively, this means that the mean differences between these two learning models are not significant. The significance value for the application of the CUP model with the Contextual approach and the Direct Instruction model is $0{,}00 < 0{,}05$, therefore, the application of the CUP model with the Contextual approach and the Direct Instruction model shows a significant difference. Furthermore, the significance value for the application of the PBL model with Contextual and the Direct Instruction model is $0{,}001 < 0{,}05$, it is concluded that the application of the PBL model with open-ended and the Direct Instruction model is different, meaning that the two models have a significant difference in mean.

Table 15. Results of the Tukey

(I) Class	(J) Class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Exsperimental Class I (CUP)	Exsperimental Class II (PBL)	3.23443	4.97789	.789	-8.6220	15.0908
	Contreol Class	40.42305*	4.97789	.000	28.5666	52.2795
Exsperimental Class II (PBL)	Exsperimental Class I (CUP)	-3.23443	4.97789	.789	-15.0908	8.6220
	Kelas Kontrol	37.18862*	4.97789	.000	25.3322	49.0405
Control Class	Exsperimental Class I (CUP)	-40.42305*	4.97789	.000	-52.2795	-28.5666
	Exsperimental Class II (PBL)	37.18862*	4.97789	.000	-49.0405	-25.3322

Discussion

Based on the results of the analysis, there is a significant effect on students' mathematical conceptual understanding when applying the CUP model with a contextual approach and PBL with a contextual approach in the learning process. From this explanation, the application of both learning models contributes to improving students' mathematical conceptual understanding. Supported by the views of Nurfaqihah et al. (2023) and Manurung & Manurung (2024) the CUP learning model has a positive and significant effect on students' mathematical concept comprehension ability. Furthermore, according to Silalahi et al. (2023), Problem-Based Learning (PBL) model influences students' mathematical concept comprehension abilities. Furthermore, Nababan et al. (2024) state that (1) the Problem-Based Learning (PBL) model is effective in enhancing conceptual understanding, and (2) the Problem-Based Learning (PBL) model is effective in improving learning outcomes, specifically conceptual understanding. Test results indicate that learning approaches that position students as meaning-makers whether through CUP or PBL with contexts closely aligned with students' experiences are more effective in building conceptual understanding than direct instruction. This finding makes sense because conceptual understanding is not formed through exposure to formulas alone, but through the process of connecting definitions, properties, examples, and representations of concepts to meaningful situations. Contextual approaches provide a cognitive "anchor" so that students do not merely memorize procedures, but understand why procedures work and when they are appropriate to use.

The equivalence of impact between CUP and PBL can be understood through the similarity of the learning mechanisms that both approaches activate. CUP emphasizes a conscious transition from conceptual to procedural understanding. PBL requires students to construct concepts through challenging problems. When both are combined with a contextual approach, the core process that occurs becomes similar: students interpret problems, choose representations, formulate reasons, and then check the consistency of their answers with

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concepts. Under these conditions, differences in "model labels" may diminish because what matters most is the quality of the tasks, how teachers facilitate discussions, and opportunities for students to test their ideas. The contrast with Direct Instruction suggests that direct instruction tends to be more effective for procedural efficiency but less effective for deep conceptual understanding if not accompanied by exploration of meaning. DI often focuses activities on uniform examples, steps, and exercises. This approach can help students who already understand the concepts to accelerate their skills, but risks causing other students to memorize patterns without understanding the conceptual structure. As a result, students appear to "know" the material when faced with similar problems, but falter when the context changes, the representation changes, or they are asked to provide a rationale.

These findings also reinforce the idea that a contextual approach serves as a catalyst, not merely an adjunct. The right context encourages students to "reconstruct" concepts: they identify relevant information, model the situation, and then map that model to mathematical concepts. When teachers ask students to explain why their strategies align with the concepts, students practice distinguishing between facts, definitions, and logical consequences. This process deepens conceptual understanding because students build a network of meaning, rather than a sequence of steps. On the classroom instruction side, these findings point to two practical implications. First, teachers need to structure activities so that students follow a sequence: understanding the situation, expressing initial ideas, comparing strategies, and then confirming formal concepts. This sequence can be present in both CUP and PBL, as long as teachers allow time for discussion and justification. Second, teachers need to assess conceptual understanding through variations in representations and contexts, not just the accuracy of the final answer. If assessment emphasizes only the final result, students will continue to choose "safe" strategies, such as simply following procedures. Literature cited by you aligns with this pattern. Susanty et al. (2023) assert that CUP is effective for conceptual understanding because it guides students to link the meaning of concepts with the procedures used. Rahma & Kurniawati (2024) assert that PBL can strengthen conceptual understanding because students construct concepts through problem-solving and argumentation.

Conclusion

Research confirms that the implementation of the Conceptual Understanding Procedural (CUP) and Problem-Based Learning (PBL) models using a contextual approach is effective in improving students' mathematical conceptual understanding compared to Direct Instruction. These findings are significant because they demonstrate that conceptual understanding is more robustly developed when students engage with meaningful situations, construct mental representations, select strategies, and provide logical explanations. Further test results also indicate that CUP and PBL yield equivalent outcomes in the context of this study, making both equally viable as learning alternatives to strengthen conceptual understanding. This study has limitations due to its quasi-experimental design, meaning control over external variables is not entirely rigorous, including potential differences in class characteristics, teacher teaching styles, and student interaction dynamics. Additionally, the scope of the study is limited to a single school and a single grade level, so generalization to other school contexts must be done cautiously. Another limitation relates to the duration of the intervention and the focus of the material, so the long-term effects on concept retention and transfer to other mathematics topics have not been tested. Future research needs to test the effectiveness of CUP and contextual PBL on different materials, with longer intervention durations, and involving a broader and more diverse sample. Further research should also include process data, such as analyses of student strategies, the quality of arguments, and the implementation of learning, to provide a stronger explanation of the mechanisms underlying the model's effectiveness. Additionally, assessments should be expanded to include retention tests and transfer tests to ensure that improvements occur not only in contexts with similar problems but also in the ability to apply concepts to new situations.

Conflict of Interest

The author declares no conflict of interest.

Authors' Contributions

The first author, T.F., understood the research concept presented and collected the data, prepared the research instruments and methodology, organized and analyzed the data, and discussed the results. The other two authors, N.H. and W.S., served as research advisors for this study and actively participated in the development of the theory and methodology, the organization and analysis of the data, the discussion of the results, and the approval of the final version of the manuscript. All authors confirm that the final version of this paper has been read and approved. The total percentage of contribution to the conceptualization, drafting, and revision of this paper is as follows: T.F.: 40%, N.H.: 30%, dan W.S.: 30%.

Data Availability Statement

The authors state that data supporting the findings of this study will be provided by the corresponding author, [N.H.], upon reasonable request.

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