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Contextual Media as a Strategy to Improve Students' Conceptual Understanding and Learning Independence

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Abstract

Mathematics learning in elementary schools requires students to have a good understanding of concepts and adequate learning independence. However, learning that is still teacher-centered and does not connect the material to real contexts causes students to have difficulty understanding abstract concepts and not demonstrate optimal learning independence. Previous research has shown the benefits of contextual media in learning, but studies that simultaneously examine its effects on mathematical concept understanding and learning independence of elementary school students are still limited. This study aims to analyze the effect of contextual learning media on mathematical concept understanding and learning independence of fifth-grade students. The study used a quantitative approach with a quasi-experimental pretest-posttest control group design. The study sample consisted of 50 fifth-grade students of SDN Keleyan 2 Socah, consisting of 25 students in the experimental class and 25 students in the control class. The research instruments included a concept understanding test and a learning independence questionnaire. Data were analyzed using validity, reliability, normality, homogeneity, independent samples t-test, and effect size tests. The results showed that the average posttest conceptual understanding score in the experimental class was higher than the control class (81.36 vs. 66.96; $p = 0.002$; $d = 0.945$). The average posttest learning independence score in the experimental class was also higher than the control class (60.68 vs. 46.72; $p < 0.001$; $d = 1.356$). Thus, contextual learning media effectively improved students' understanding of mathematical concepts and learning independence. These findings emphasize the importance of using media that are close to students' real experiences in learning mathematics in elementary schools.

Keywords: Learning media; Contextual; Concept understanding; Learning independence

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INTRODUCTION

Mathematics learning in elementary school is expected not only to train students to obtain correct answers, but also to develop a deep understanding of concepts and the capacity to learn independently. In mathematics education, conceptual understanding is a central indicator of meaningful learning because students are not merely required to memorize formulas or procedures, but to interpret mathematical symbols, connect representations, explain relationships among ideas, and apply those ideas in different situations (Hiebert & Carpenter, 1992; National Council of Teachers of Mathematics, 2000; Hulyadi et al., 2024; O'Reilly et al., 2022). At the elementary level, this issue becomes especially important because mathematical concepts introduced in the early grades form the basis for later learning. Weak understanding at this stage often persists and affects students' ability to learn more complex topics in subsequent grades. In parallel, learning independence is increasingly recognized as an essential educational outcome because students are expected to demonstrate initiative, self-confidence, persistence, and responsibility in completing learning tasks (Paris & Paris, 2001;

Zimmerman, 2000; Zimmerman & Schunk, 2011). In the context of mathematics, conceptual understanding and learning independence are not separate qualities; rather, they tend to reinforce each other. Students who understand concepts more meaningfully are generally more capable of engaging in problem solving, while students with stronger self-regulation are more prepared to monitor their reasoning, manage their effort, and persist when facing difficulties (Butler & Winne, 1995; Pintrich, 2000; Schraw et al., 2006; Rivas et al., 2022).

From a pedagogical perspective, one major challenge in elementary mathematics is that many concepts are often introduced in forms that are too abstract, procedural, and detached from the students' lived experiences. Although mathematics is inseparable from everyday life, classroom practices frequently present it as a set of rules to be memorized rather than a meaningful way of interpreting situations. Boaler (1993) argued that context in mathematics learning is not an accessory element, but a crucial bridge that can make mathematical ideas more meaningful for students. Likewise, Boaler (1998) showed that when learning environments provide richer and more open contexts, students tend to develop broader and deeper mathematical understanding than when they are confined to closed, purely procedural tasks. This perspective is consistent with constructivist views of learning, which emphasize that knowledge is actively constructed through experience, interaction, and interpretation rather than passively received from the teacher (Dewey, 1938; Vygotsky, 1978; Jonassen, 1999). Thus, meaningful mathematics instruction at the elementary level should help students connect formal symbols and operations with concrete contexts that they can recognize, interpret, and manipulate (Hidayana & Lianingsih, 2025; Kaminski & Sloutsky, 2020).

However, in practice, elementary mathematics instruction is still often dominated by teacher-centered explanation, repetitive exercises, and decontextualized examples. Under such conditions, students may learn to imitate procedures without fully understanding why those procedures work or how the concepts can be applied in practical situations. This problem is particularly important in Grade V whole-number learning. Whole numbers are often treated as basic and simple material, yet in fact they require students to compare magnitudes, order values, perform operations, interpret numerical relationships, and solve quantitative problems in context. The topic is therefore foundational, not trivial. If students fail to understand whole-number concepts meaningfully, they may encounter continuing difficulties in arithmetic reasoning, problem solving, and later mathematical topics. Preliminary observations reported in this manuscript indicate that students at SDN Keleyan 2 Socah still experienced difficulty in understanding number operations and tended to be passive during mathematics lessons, showing limited initiative and low confidence when dealing with tasks independently . These classroom conditions suggest that the issue is not only cognitive but also behavioral and motivational: students are not simply failing to answer correctly, but are also not sufficiently engaged as active learners in constructing understanding.

This problem becomes more serious when viewed from the perspective of learning independence. Learning independence does not emerge automatically; it develops when instructional environments provide opportunities for students to make decisions, regulate effort, monitor progress, and take responsibility for their learning processes (Zimmerman, 2000; Winne, 1995; Loyens et al., 2008). In mathematics classrooms that remain highly teacher-directed, students often depend excessively on teacher explanation and external guidance. As a result, they may complete tasks only when instructed, hesitate to explore alternative solutions, and show limited confidence in working through unfamiliar problems. Paris and Paris (2001) emphasized that classrooms play a critical role in developing self-regulated learning when instructional activities encourage students to plan, reflect, and evaluate their own work. Likewise, Mahayani et al. (2021) found that self-regulated learning positively affects mathematical conceptual understanding and self-confidence. Supriadi et al. (2021) also reported that learning designs that support self-regulation can improve conceptual understanding in mathematics. These findings indicate that efforts to improve mathematics learning quality in elementary school should not focus only on test performance, but also on how learning environments shape students' independent engagement with mathematical ideas.

One approach that has received sustained attention in the literature is contextual learning. Broadly, contextual learning seeks to connect instructional content with situations that are meaningful, familiar, and relevant to students' real lives, so that knowledge is not learned in isolation from experience (Trianto, 2009; Lave & Wenger, 1991). In mathematics, contextual learning is particularly relevant because students often need concrete referents to make sense of abstract symbols and relationships. Prior studies have shown that contextual approaches can support student engagement and conceptual understanding. Hani et al. (2024), for example, found that contextual teaching and learning supported by animated video contributed positively to students' mathematical conceptual understanding. Hidayat et al. (2023) also reported that contextual learning through digital platforms could improve students' mathematical conceptual understanding. Halawa and Harefa (2024) further showed that a contextual teaching and learning model combined with discovery learning positively affected students' mathematical problem-solving ability. Collectively, these studies support the argument that contextualization helps students perceive mathematics as meaningful rather than merely procedural (Hidayana & Lianingsih, 2025; Hulyadi et al., 2024; Muhali et al., 2025).

Nevertheless, although previous studies are encouraging, the existing literature still leaves several important questions unresolved. First, much of the prior research has emphasized only one dominant outcome, such as learning achievement, conceptual understanding, motivation, or problem-solving ability. Fewer studies have examined, within a single intervention framework, how contextual media may simultaneously influence both conceptual understanding and learning independence. This is a significant limitation because in elementary mathematics these two outcomes are pedagogically interconnected. Students who are able to interpret and apply concepts meaningfully are more likely to participate actively and confidently, while students with greater independence are more likely to sustain effort and reflection during conceptual learning. Without examining both outcomes together, the literature provides only a partial account of how contextual interventions function in classroom practice.

Second, the operationalization of contextual learning in prior studies has been highly varied, making the evidence difficult to compare directly. Some studies use general CTL models, others employ video-assisted media, digital modules, YouTube platforms, or contextual worksheets, while still others combine contextual learning with broader pedagogical strategies (Hani et al., 2024; Hidayat et al., 2023; Febriyanti et al., 2025; Halawa & Harefa, 2024). This variation is important because contextual learning is not a single uniform intervention. A contextual approach delivered through broad classroom discussion is different from a contextual medium that is concrete, specific, reusable, and embedded in a highly familiar school environment. Therefore, even though the literature generally supports contextualization, it remains unclear what type of contextual support is most effective for improving both conceptual understanding and learning independence in elementary mathematics. In other words, what is already known is that contextual approaches can help; what is not yet sufficiently known is which contextual design works best, under what conditions, and through what pedagogical mechanism (Lubna et al., 2023; Muhali et al., 2025).

Third, previous evidence has not sufficiently addressed highly localized and authentic micro-contexts drawn directly from students' immediate school environment. Much contextual instruction uses broad "real-life examples," but these examples are not always drawn from contexts students routinely encounter in their own daily school experience. This distinction matters. A context that is genuinely embedded in students' lived environment may activate stronger familiarity, relevance, and cognitive anchoring than a context that is merely realistic in a general sense. In this study, the context is not generic; it is the actual school canteen price list used as a medium for learning whole numbers. This context is pedagogically significant because it places mathematical activity within a numerical environment that students directly observe and potentially interact with in their daily school life. Students are not asked merely to imagine quantities; they are asked to interpret prices, compare values, calculate totals, determine differences, and estimate remaining amounts within a setting that is concrete, routine, and socially meaningful. Such a localized design has rarely been articulated as a distinct empirical contribution in previous studies.

Based on those considerations, the novelty of this study lies not simply in "using contextual media," because that claim alone would be too weak. Its novelty is located in the design of an original, school-canteen-based contextual medium for Grade V whole-number learning, and in the proposition that this medium operates through a more specific pedagogical mechanism than general CTL. First, the intervention is built from an authentic school-based numerical environment rather than from a generic or externally imposed real-life illustration. Second, the medium does not merely contextualize examples; it structures student activity around comparison, ordering, calculation, and decision-making tasks that require both conceptual processing and self-regulatory engagement. Third, the study does not treat conceptual understanding and learning independence as unrelated outcomes; instead, it positions them as interconnected indicators of mathematics learning quality within one intervention model. In this sense, the study contributes not only by testing effectiveness, but also by refining how contextual media can be conceptualized: not as a broad instructional label, but as a specific, situated, and pedagogically targeted medium.

This study is therefore important in both theoretical and practical terms. Theoretically, it extends the literature on contextual mathematics learning by focusing on an authentic micro-context and by integrating cognitive and self-regulatory outcomes within one empirical design. Practically, it provides evidence that may help teachers move beyond procedural instruction by using learning media that are closer to students' daily realities and more likely to stimulate active engagement. In Grade V whole-number learning, such an intervention is particularly relevant because students are at a stage where they are transitioning from dependence on concrete support toward greater abstraction, yet still require familiar contexts to anchor meaning. If a localized contextual medium can strengthen both conceptual understanding and learning independence, then it offers a promising strategy for improving the quality of elementary mathematics instruction.

Accordingly, this study aims to examine the effect of school-canteen-based contextual media on fifth-grade students' conceptual understanding and learning independence in whole-number learning. The study addresses two research questions: (1) Does the use of school-canteen-based contextual media produce significantly higher conceptual understanding than conventional instruction? and (2) Does the use of school-canteen-based contextual media produce significantly higher learning independence than conventional instruction? Based on these questions, the hypotheses are formulated as follows: H1**:** Students who learn through school-canteen-based contextual media demonstrate significantly higher conceptual understanding than students who learn through conventional instruction. H2: Students who learn through school-canteen-based contextual media demonstrate significantly higher learning independence than students who learn through conventional instruction. Through these hypotheses, the study seeks to provide more precise empirical evidence on how a highly specific contextual medium may improve the quality of mathematics learning in elementary school.

METHOD

Research Methodology

This research uses a quantitative methodology with a true experimental design using a pretest-posttest control group framework. This design was chosen because of its ability to provide a comparative analysis of the impact of the treatment on the variables being studied. The experimental group was given therapy using contextual learning media for mathematics, while the control group continued to use the conventional teaching approach. The difference in learning outcomes between the two groups underlies the evaluation of the impact of contextual media on students' conceptual understanding and learning independence. This research was conducted through the following design.

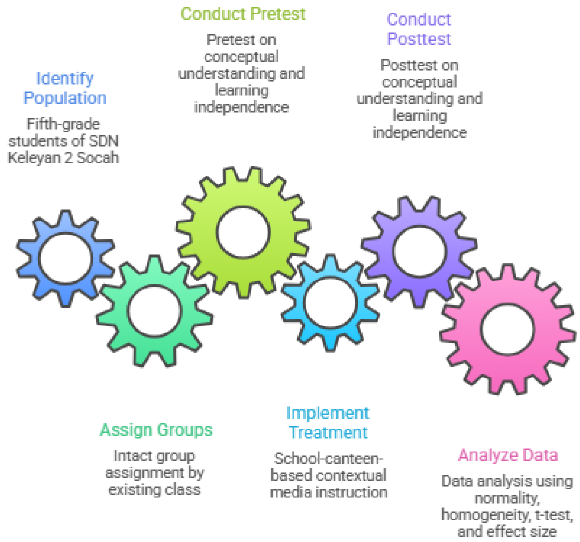

Figure 1. Research design of contextual learning

Research Subjects

The research population includes all students from grades 1 to 6 at Keleyan 2 Socah Elementary School, totaling 289 students. The research sample was determined from this population using a saturation sampling approach, where all eligible individuals from the population were directly included as the sample. All fifth-grade children were selected as research subjects according to their relevance to the study's objectives. The sample consists of 50 students, divided into two classes: Class V-A as the experimental group and Class V-B as the control group, each consisting of 25 students. The sample selection involved all fifth-grade students without using a random approach, thus ensuring equal opportunity for participation among all children. The selection criteria are based on various academic factors, including the consistency of educational achievement and relatively similar cognitive development, a sufficient number of participants for division into experimental and control groups, as well as ease of access and management due to the use of existing classes. Sample selection, using these techniques and criteria, is practical and methodological, ensuring that the study results have strong validity and accurately reflect real-world conditions (Susetyo & Lie, 2025).

Research Instruments

The research instruments include concept understanding assessments and a learning independence questionnaire. The concept understanding test questions are designed according to elementary school curriculum indicators, evaluating students' ability to recognize, explain, and apply mathematical concepts. The learning independence questionnaire is constructed using a Likert scale, covering variables such as time management, learning initiative, self-confidence, and accountability for learning outcomes. The content validity of the instrument is determined thru expert evaluation, while reliability is assessed using the Cronbach's Alpha coefficient to verify measurement consistency.

Research Intervention

This research intervention lasted for four weeks and consisted of twelve meetings, where the experimental group used contextual learning media specifically tailored for the fifth-grade elementary school natural numbers material. The medium consists of a list of food and drink prices available in the school canteen as follows:

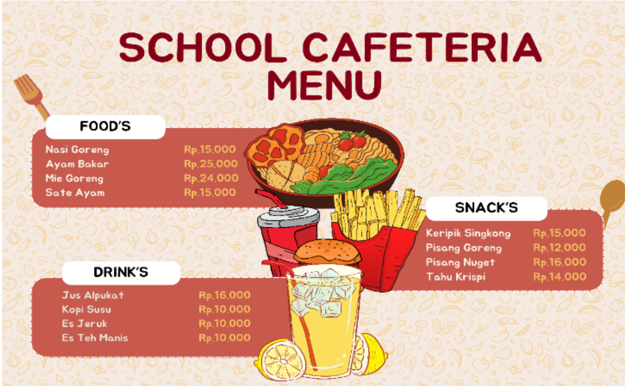

Figure 2. Menu prices for food and beverages at the school canteen

Each simultaneous meeting plays an important role, starting with learning objectives that highlight the understanding of integer concepts and their application in everyday life, as well as enhancing students' independence in learning. Aperception is conducted by posing triggering questions related to students' experiences, providing them with a list of items and their prices in whole numbers, and then instructing them to calculate the total shopping cost, compare prices, arrange items from the cheapest to the most expensive, or determine the remaining funds. These questions assess conceptual understanding while simultaneously developing students' self-regulation skills in problem-solving.

At the end of each session, the teacher and students collaboratively formulate conclusions and summaries that emphasize the importance of natural numbers as a vital tool for addressing real-world challenges, while simultaneously developing an independent and systematic learning approach. This approach places contextual media for integers as a tool for content understanding as well as a catalyst for enhancing learning independence.

Data Collection Technique

Data collection was carried out by administering pre-tests and post-tests to both groups. Pretest assesses the basic competencies of students and establishes equivalence between the experimental and control groups. Post-therapy tests were conducted after the therapy to evaluate the changes that had occurred. Test and questionnaire data were analyzed using IBM SPSS software version 27 for Windows. The analysis phase includes the assessment of validity, reliability, homogeneity, and normality. The homogeneity test evaluates the similarity of variances between groups, while the normality test assesses whether the data distribution meets the parametric assumptions. The independent sample t-test is used to analyze the hypothesis and identify significant differences between the experimental and control groups. The significance value obtained supports the findings regarding the impact of contextual learning media on students' conceptual understanding and learning independence.

Data Analysis

Data analysis in this study was conducted using various methodological techniques. The research instruments were initially assessed using tests of validity, reliability, homogeneity, and normality. Content validity is determined thru expert evaluation, while the reliability of the instrument is assessed using the Cronbach's Alpha coefficient, which indicates a satisfactory level of internal consistency. The Levene test is used to analyze the homogeneity of variances between groups, and the Kolmogorov–Smirnov test is used to assess the distribution of data.

Pretest analysis was conducted using an independent sample t-test to confirm the absence of significant differences between groups before therapy was administered. The posttest study used an independent sample t-test, utilizing IBM SPSS software version 27, to determine significant differences between the experimental and control groups in conceptual understanding and learning independence. These findings provide an empirical basis for assessing the effectiveness of contextual learning media in enhancing students' conceptual understanding and promoting learning independence in primary education.

RESULTS AND DISCUSSION

Results

This study aims to investigate the impact of contextual learning media on the understanding of mathematical concepts and the independence of fifth-grade students at Keleyan 2 Socah Elementary School. The independent sample t-test analysis shows a significant difference between the experimental group using contextual media and the control group using conventional techniques, as indicated by the following statistical results:

Table 1. Statistical analysis of average concept understanding scores of students

	Class	N	Mean	Std. Deviation	Std. Error Mean
Pretest	Experiment Class	25	42.00	21.564	4.313
	Control Class	25	48.72	22.203	4.441
Posttest	Experiment Class	25	81.36	10.965	2.193
	Control Class	25	66.96	18.548	3.710

Group statistical data shows that at the pretest stage, the average score of the experimental class (42.00) was lower compared to the control class (48.72), indicating that the initial understanding of mathematical concepts in the experimental class was quite lacking. After the intervention using contextual learning media, the experimental class showed a significant improvement, reaching an average posttest score of 81.36, compared to the control class score of 66.96. This difference indicates that contextual media is more effective in enhancing conceptual understanding compared to traditional teaching methods. The Table 2 displays the results of the independent sample t-test.

Table 2. The results of the independent sample t-test on the concept understanding variable

Group		Levene's F	Levene's Sig.	t	df	Sig.	Mean Diff.	SE	95% CI	
									Lower	Upper
Pretest	Equal var. assumed	.007	.936	-1.086	48	.283	-6.720	6.190	-19.166	5.726
	Equal var. not assumed			-1.086	47.959	.283	-6.720	6.190	-19.166	5.726
Posttest	Equal var. assumed	9.193	.004	3.342	48	.002	14.400	4.309	5.735	23.065
	Equal var. not assumed			3.342	38.950	.002	14.400	4.309	5.683	23.117

The findings of the t-test for the pretest revealed a significance value of 0.283 (>0.05), indicating no significant difference between the experimental group and the control group before the treatment. This criterion verifies that both groups have comparable initial abilities. Conversely, the posttest yielded a significance value of 0.002 (<0.05), indicating a substantial change between the two groups after the therapy. As a result, the application of contextual learning media has proven effective in enhancing students' understanding of mathematics learning. The effect size test on the concept understanding variable is as follows.

Table 3. Results of the independent samples effect sizes test on the concept understanding variable

Group		Standardizer[a]	Point Estimate	95% CI	
				Lower	Upper
Pretest	Cohen's d	21.886	-.307	-.863	.252
	Hedges' correction	22.235	-.302	-.850	.248
	Glass's delta	22.203	-.303	-.860	.261
Posttest	Cohen's d	15.236	.945	.355	1.526
	Hedges' correction	15.479	.930	.350	1.502
	Glass's delta	18.548	.776	.174	1.365

The effect size results provide a summary of the magnitude of the intervention's impact. In the pretest, the Cohen’s d value of -0.307 was classified as low, indicating that the initial difference between the groups could be ignored. In the posttest, the Cohen’s d value of 0.945 was categorized as substantial, indicating that the intervention significantly improved conceptual understanding. Hedges' adjustment (0.930) and Glass' delta (0.776) further reinforce the idea that the impact of the intervention is categorized as moderate to large, thus proving that contextual learning media not only succeeded statistically but also significantly improved the quality of students' conceptual understanding. The findings of the independent sample t-test for the hypothesis test on learning independence are as follows.

Table 4. Standard Statistical Analysis of Mean Student Learning Independence Scores

Class		N	Mean	Std. Deviation	Std. Error Mean
Pretest	Experiment Class	25	33.68	7.273	1.455
	Control Class	25	26.96	8.488	1.698
Posttest	Experiment Class	25	60.68	8.158	1.632
	Control Class	25	46.72	12.054	2.411

The results of the descriptive analysis show that during the pretest stage, the experimental group achieved an average learning independence score of 33.68, while the control group achieved an average score of 31.12. The difference was minimal, so the initial conditions of both groups can be considered almost equivalent. At the posttest stage, the experimental class showed a significant improvement, reaching an average score of 60.68, while the control class only reached 46.72. This shows that the intervention given to the experimental group was more effective in improving learning independence compared to the one given to the control group. The results of the independent sample t-test are shown in the Table 5.

Table 5. Results of the independent sample t-test on the variable of learning independence

Group		Levene's F	Levene's Sig.	t	df	Sig.	Mean Diff.	SE	95% CI	
									Lower	Upper
Pretest	Equal var. assumed	4.209	.046	1.059	48	.295	2.560	2.417	-2.299	7.419
	Equal var. not assumed			1.059	44.615	.295	2.560	2.417	-2.309	7.429
Posttest	Equal var. assumed	2.902	.095	4.796	48	.000	13.960	2.911	8.107	19.813
	Equal var. not assumed			4.796	42.175	.000	13.960	2.911	8.086	19.834

The t-test conducted at the pretest stage yielded a t-value of 1.059 with a significance level of $p = 0.295$ (> 0.05), indicating no significant difference between the experimental group and the control group before the treatment. As a result, both groups can be considered to have very similar initial conditions. On the other hand, in the posttest phase, the t-value increased to 4.796 with a significance level of $p < 0.001$. The results show a significant difference between the experimental group and the control group posttest, leading to the conclusion that the intervention effectively promotes learning independence. The effect size test on the learning independence variable is as follows.

Table 6. Results of the effect size test for the variable of learning independence

Group		Standardizer[a]	Point Estimate	95% CI	
				Lower	Upper
Pretest	Cohen's d	8.544	.300	-.259	.856
	Hedges' correction	8.681	.295	-.255	.842
	Glass's delta	9.649	.265	-.297	.822
Posttest	Cohen's d	10.292	1.356	.734	1.968

Group		Standardizer[a]	Point Estimate	95% CI	
				Lower	Upper
	Hedges' correction	10.456	1.335	.722	1.937
	Glass's delta	12.054	1.158	.506	1.792

The results of the effect size test provide a summary of the magnitude of the change between the two groups being tested. During the pretest phase, a Cohen’s d value of 0.300 categorized the effect as small, indicating that the initial difference between the groups was minor. At the posttest stage, the Cohen’s d value significantly increased to 1.356, categorizing it as very large, which indicates that the therapy produced a statistically significant difference and had a substantial and significant effect on improving students' learning independence.

Discussion

Research findings indicate that before the intervention, the experimental class had a lower understanding of mathematical concepts compared to the control class. After the implementation of contextual learning media, the experimental class showed a significant improvement, achieving an average posttest score of 81.36, which is in stark contrast to the control class that only reached a score of 66.96. The t-test showed no significant difference at the pretest stage ($p = 0.283$), indicating that the initial conditions of both groups were the same. In contrast, at the posttest phase, a significant difference was observed ($p = 0.002$), indicating that contextual media effectively improved conceptual knowledge.

The results shows that the experimental class increased from a pretest mean of 42.00 to a posttest mean of 81.36, while the control class increased from 48.72 to 66.96. Panel B indicates that there was no significant baseline difference at pretest (mean difference = -6.720; $p = 0.283$; 95% CI [-19.166, 5.726]), but a significant advantage emerged for the experimental class at posttest (mean difference = 14.400; $p = 0.002$; 95% CI [5.735, 23.065]). Panel C shows negligible pretest effect sizes, whereas posttest effect sizes were large, with Cohen’s d = 0.945, Hedges’ g = 0.930, and Glass’s delta = 0.776, indicating that contextual media had a substantial positive effect on students’ conceptual understanding. The implementation of contextual learning media has a positive and effective impact in fostering conceptual understanding of mathematics as described in Figure 3.

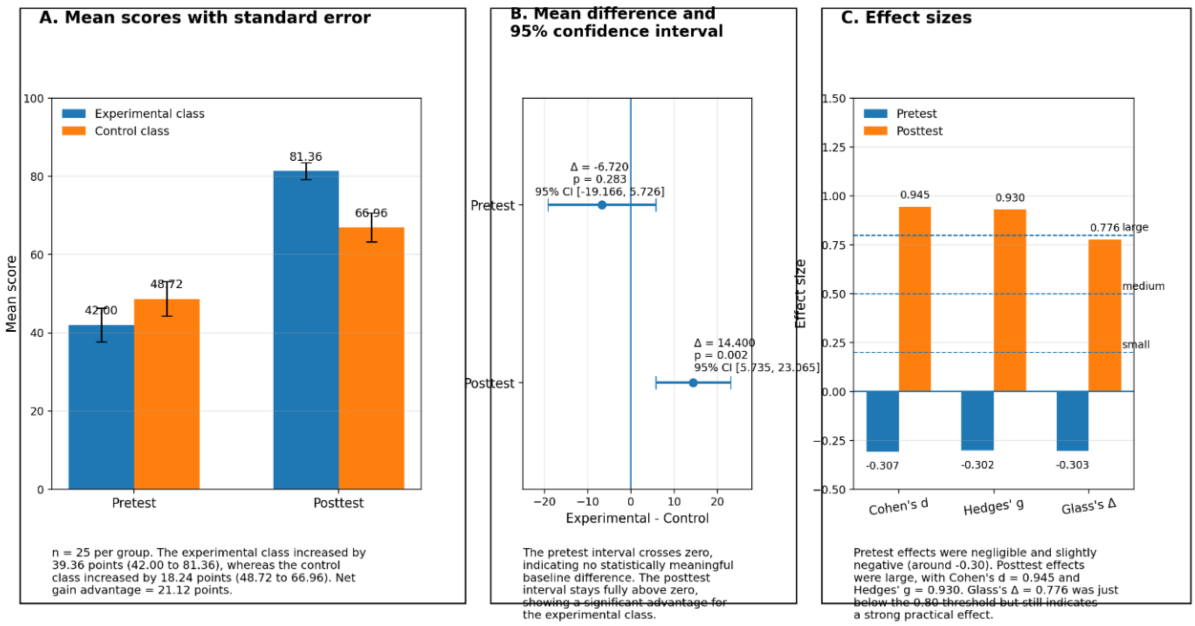

Figure 3. Combines the descriptive, inferential, and practical effect results of students’ concept understanding in the experimental and control classes.

Figure 3 provides a more robust interpretation of the effectiveness of contextual media because it integrates descriptive results, inferential evidence, and practical effect estimates into a single display. The figure shows that the experimental class started from a slightly lower baseline than the control class, with a pretest mean of 42.00 compared to 48.72, yet after the intervention the experimental class achieved a substantially higher posttest mean of 81.36, whereas the control class reached only 66.96. This pattern is important because it indicates that the contextual intervention did not merely preserve an existing advantage, but accelerated conceptual growth in a group that initially appeared less prepared. Substantively, this suggests that contextual media can function as a compensatory instructional support, helping learners move beyond procedural responses toward deeper conceptual engagement. This interpretation is consistent with the view that conceptual understanding in mathematics requires students not only to obtain correct answers, but also to interpret symbols, connect representations, explain relationships, and apply ideas meaningfully across situations (Hiebert & Carpenter, 1992; Kholid et al., 2021).

The inferential panel of Figure 3 further strengthens this conclusion. At pretest, the difference between groups was not statistically significant, with $p = 0.283$ and a 95% confidence interval ranging from -19.166 to 5.726, indicating that the initial difference fell within ordinary sampling variation. At posttest, however, the mean difference increased to 14.400 with $p = 0.002$ and a 95% confidence interval from 5.735 to 23.065, showing that the superiority of the experimental class after treatment was statistically robust. Thus, the advantage of the experimental class cannot be reduced to random fluctuation. Rather, Figure 3 suggests that contextual media contributed to a measurable shift in mathematical understanding. In this respect, the result aligns with prior evidence showing that contextual learning environments support conceptual growth more effectively than decontextualized or purely procedural instruction (Boaler, 1993, 1998; Hani et al., 2024; Hidayat et al., 2023).

The practical significance of the intervention is especially visible in the effect size panel. The pretest effect sizes were negligible and slightly negative, with Cohen's $d = -0.307$, Hedges' correction = -0.302, and Glass's delta = -0.303, confirming the absence of a meaningful baseline advantage in the experimental class. In contrast, the posttest effect sizes increased markedly, with Cohen's $d = 0.945$, Hedges' correction = 0.930, and Glass's delta = 0.776. The convergence of these indices is important because it shows that the effect is not dependent on a single metric. Cohen's d and Hedges' correction both indicate a large practical effect, while Glass's delta remains moderately large, suggesting that the intervention produced not only statistical significance but also substantial educational impact in classroom terms. This supports the argument that contextual media improved students' conceptual understanding in a way that is meaningful for instructional practice, not merely detectable through hypothesis testing.

Pedagogically, this result is plausible because the intervention was grounded in an authentic school canteen price list, not in abstract numerical exercises detached from students' daily experiences. Students were asked to compare prices, calculate totals, order values, determine differences, and estimate remaining amounts using a context they encountered in everyday school life. Such a design is likely to have strengthened conceptual understanding because it helped students attach mathematical meaning to familiar situations. This interpretation is strongly supported by constructivist perspectives, which emphasize that knowledge is actively built through experience, interaction, and interpretation rather than passively received from the teacher (Dewey, 1938; Vygotsky, 1978; Jonassen, 1999). It is also consistent with Boaler's argument that context serves as a bridge that makes mathematical ideas more meaningful, as well as with Kaminski and Sloutsky's finding that contextualized materials can improve elementary students' mathematical learning. More recent evidence likewise indicates that contextual learning can enhance mathematical literacy, conceptual understanding, and problem solving when students engage with meaningful and recognizable situations (Hidayana & Lianingsih, 2025; Halawa & Harefa, 2024).

Another critical implication is that Figure 3 should not be interpreted only as evidence of cognitive improvement, but also as an indirect sign of stronger student engagement. The manuscript itself positions conceptual understanding and learning independence as pedagogically interconnected outcomes, arguing that students who understand concepts more meaningfully are more likely to participate actively and confidently, while students with stronger self regulation are more likely to sustain effort and reflection during learning. This claim is supported by prior literature showing that self regulated learning environments foster mathematical conceptual understanding, self confidence, and more persistent engagement with academic tasks (Paris & Paris, 2001; Zimmerman, 2000; Mahayani et al., 2021; Supriadi et al., 2021). In a similar vein, Merawan et al. (2021) reported that contextual teaching and learning supports self regulated learning, which suggests that the present intervention may have worked not only by making content more concrete, but also by reorganizing classroom participation from passive reception to more active and self directed mathematical reasoning.

The present findings also extend earlier studies in an important way. Previous research has shown that contextual learning supported by animation media improves mathematical conceptual understanding, that contextual learning through digital platforms enhances mathematical concept mastery, and that contextual teaching combined with discovery learning improves mathematical problem solving (Hani et al., 2024; Hidayat et al., 2023; Halawa & Harefa, 2024). However, as noted in the manuscript, much of the earlier literature focused on only one dominant outcome or relied on broader contextual formats such as videos, digital modules, or online platforms. In contrast, this study demonstrates that a highly localized and school based contextual medium can simultaneously produce strong cognitive benefits within elementary mathematics instruction. Therefore, Figure 3 does not merely confirm previous findings, but refines them by showing that contextualization becomes especially powerful when it is embedded in a concrete micro context that students directly recognize and regularly experience.

Even so, a critical reading of Figure 3 still requires caution. The study involved only 50 students from a single elementary school and used intact classes rather than randomized assignment, so the findings should be generalized carefully. In addition, the experimental class started from a lower pretest mean than the control class, which might superficially suggest a catch up pattern. However, this alternative explanation is weakened by the non significant pretest difference, the confidence interval crossing zero at pretest, and the large posttest effect sizes. Accordingly, although Figure 3 does not provide universal proof for all educational contexts, it offers strong evidence that school canteen based contextual media can substantially improve fifth grade students' mathematical conceptual understanding in the setting examined in this study.

The analysis of the learning independence variable shows that the initial conditions of both groups are comparable, with an average pretest score of 33.68 for the experimental group and 31.12 for the control group. The t-test conducted at the pretest stage yielded $p = 0.295$ (>0.05), indicating no significant difference before the therapy. After the intervention, the experimental group showed a significant improvement, reaching an average posttest score of 60.68, while the control group only reached a score of 46.72. The t-test conducted during the posttest phase revealed $p < 0.001$, indicating a significant difference between the two groups after the therapy. A substantial effect size (Cohen's $d = 1.356$) indicates that the intervention significantly improved students' learning independence. The results of this study are relevant when compared to previous research findings. Febriyanti et al. (2025) found that the use of Contextual Learning makes students more motivated and able to learn independently. Hidayat et al. (2023) found that the independent learning approach positively impacts students' understanding of mathematical concepts and their self-confidence. The paradigm of self-directed learning states that active engagement enhances students' ability to autonomously navigate their learning processes (Henschel et al., 2022). These findings can theoretically be explained using the self-directed learning framework, where active participation in significant events enhances intrinsic motivation and students' ability to autonomously manage their learning processes (Wei et al., 2023). Students who use contextual media are more motivated to participate actively, whereas those in the control group show passivity due to the teacher-centered learning approach (Halawa & Harefa, 2024).

This research shows that contextual learning media effectively enhances two important features in mathematics education: conceptual understanding and learning independence. These findings reinforce previous studies by demonstrating that contextual media not only helps students understand abstract topics but also encourages greater independence in their learning. This aligns with the research objectives mentioned in the introduction, which is to investigate the influence of contextual media on the quality of mathematics education in elementary schools. This study contributes theoretically by enriching the literature on context-based learning and practically by offering recommendations that the incorporation of contextual media in pedagogy can effectively enhance the quality of mathematics education in elementary schools.

CONCLUSION

This study uses an independent sample T-test for concept understanding, yielding a significance value of 0.002 (< 0.05), and an independent sample T-test for learning independence, yielding a significance value of 0.000 (< 0.05). Therefore, it can be concluded that there is a significant gap in the use of contextual learning media related to concept understanding and learning independence among Grade V students at Keleyan 2 Socah Elementary School. At Keleyan 2 Socah Elementary School, the use of contextual learning media has a major impact on students' understanding and ability to independently solve arithmetic problems. Teachers should regularly incorporate contextual learning materials into their mathematics lessons.

This research has a limited scope as it was conducted only on elementary school students in one institution, focusing on the subject of mathematics. Currently, these results cannot be applied to other levels of education or other fields of research. External factors, such as teacher readiness, facility accessibility, and classroom atmosphere, may affect the effectiveness of contextual learning media.

Suggestions for future research include expanding investigations to secondary and higher education levels, as well as other domains such as language, arts, or social sciences. Interdisciplinary and cross-level research will enhance knowledge about the potential of contextual learning media as a flexible and novel teaching methodology.

RECOMMENDATION

This study shows that contextual learning media effectively enhances students' conceptual understanding and learning independence. Therefore, it is recommended that future research focus on the development of more creative and interactive learning media, particularly contextual media designed to align with students' characteristics and learning needs. Subsequent studies should investigate the long-term effects of contextual media on educational outcomes, motivation, and students' self-regulation abilities. Additionally, educator training and institutional support are crucial for the successful integration of digital media into classroom learning methodologies. Factors such as inadequate technical infrastructure, educators' digital skills, and students' access to learning devices must also be considered in implementation and future research.

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AUTHOR CONTRIBUTIONS STATEMENT

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
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Muhajir	✓	✓		✓	✓	✓		✓		✓	✓	✓		✓
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CONFLICT OF INTEREST STATEMENT
Authors state no conflict of interest.

INFORMED CONSENT
We have obtained informed consent from all individuals included in this study.

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