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Addressing Fraction Learning Challenges: Developing Contextual Student Worksheets to Strengthen Numeracy Literacy in Junior High School

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ABSTRACT

Numeracy literacy is a critical competency in mathematics education, but students often have difficulty understanding the concept of fractions contextually. This study aims to develop student worksheets based on Contextual Teaching and Learning (CTL) to improve numeracy literacy in fractions at the junior high school level, emphasizing the integration of real-life contexts and curriculum relevance. This study uses the Design Research method with the Tessmer formative evaluation approach, involving 28 junior high school students in the city of Palembang, Indonesia. The stages include needs analysis, prototype design, expert validation (materials and media), and gradual trials (one-to-one, small group, and field test). Data were collected through questionnaires, interviews, and learning outcome test, analyzed qualitatively-quantitatively to assess the validity, practicality, and effectiveness of the student worksheets. The results of the study stated that the student worksheets were declared valid based on expert assessments and very practical according to student responses. The effectiveness of the student worksheets was proven by the average class value which was included in the "Very Good" category and the high percentage of learning completion. Analysis of students' answers showed an increase in students' ability to apply fraction concepts in authentic contexts, such as visual data analysis and predictions based on quantitative information. This study contributes to the selection of CTL-based student worksheets in improving students' numeracy literacy through real problems and empirically valid structured frameworks, in accordance with the principles of the "Merdeka" Curriculum. Further research needs to improve the worksheets with clearer instructions, scaffolding according to difficulty levels, and trials in various schools with simple technology integration to increase student engagement.

Keywords: Contextual Teaching and Learning; Numeracy Literacy; Student Worksheet; Tessmer's Formative Evaluation Model.

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Introduction

Numeracy literacy, a fundamental 21st-century skill (Nityasanti, Laila, Saida, Baharudin, & Yasin, 2025; Sunarti et al., 2024), enables students to interpret, analyze, and apply mathematical concepts in real-world contexts (Genc & Erbas, 2019; Taufik, Vandita, & Ashari, 2024). Fractions are a critical yet challenging topic in mathematics education due to their abstract nature and practical relevance. Weaknesses in understanding fractions can hinder academic progress and limit students' ability to solve everyday problems, such as budgeting or data interpretation (Brown & Quinn, 2006; Obersteiner, Dresler,

Bieck, & Moeller, 2019). The urgency of this research lies in addressing this gap through innovative pedagogical tools that bridge theoretical knowledge with contextual applications. Integrating learning media and Contextual Teaching and Learning (CTL) models is expected to improve students' ability to understand and apply mathematical concepts in everyday contexts. Empirical studies have demonstrated that CTL implementation significantly improves the average scores of students' numeracy literacy (Afni, 2020), thereby strengthening understanding and practical application (Oktaviana & Putranta, 2024), as well as enabling students to analyze and solve problems logically and systematically (Afni, 2020). In addition, this approach has been shown to improve numeracy learning outcomes through active learning experiences that are relevant to students' needs, especially in solving problems based on everyday life contexts (Sari, Rahayu, & Widyaningrum, 2018). Therefore, CTL serves as an effective strategy for establishing a robust and sustainable foundation in numeracy literacy.

Previous studies have explored students' numeracy literacy influenced by various factors, such as problem solving (Iswara, Ahmadi, & Da Ary, 2022; Ladyawati & Maftuh, 2025; Masnia, Suratno, Prastiti, & Utomo, 2025; Priyatni & As' ari, 2021; Rahmah, Irianto, & Rachmadtullah, 2023), learning media (Aprilia et al., 2023; Masnia et al., 2025; Saefurohman et al., 2021). However, research on numeracy literacy influenced by student worksheets integrated with Contextual Learning (CTL) is still rare. As a result, there is a significant research gap in developing CTL-based student worksheets and seeing their effects on students' numeracy literacy skills. Furthermore, there have been no empirical studies that specifically examine the challenges and opportunities associated with CTL-based student worksheets in junior high schools.

Other studies have suggested that CTL increases students' engagement (Ilyas, Kaynat, & Salisu, 2023; Pratiwi & Iriani, 2024; Qudsyi, Wijaya, Widiasmara, & Nurtjahjo, 2018) and mathematical literacy in learning (Afni, 2020; Zahiro & Nasrulloh, 2023), while several other researchers have highlighted the effectiveness of contextual modules in improving problem-solving skills (Desnita, Festiyed, Novitra, Ardiva, & Navis, 2022; Hidayat, Marwoto, & Widiyatmoko, 2024; Sukarman, Rahayu, & El Hakim, 2021). On the other hand, the development of Student Worksheets as a tool to structure learning activities has shown an increase in student independence (Juliana, Ampera, & Sinukaban, 2024), as reported in research on geometry topics (Susanti & Wulandari, 2022). However, these studies have focused more on general mathematical competencies or non-contextual materials, with limited emphasis on the integration of numeracy literacy, especially in fraction teaching. In addition, existing Student Worksheets designs tend to prioritize procedural fluency rather than the application of concepts in meaningful contexts, leaving

a critical gap in the development of holistic numeracy skills (Hart, 2024; Jeyabal, Vasuki, & Kumar, 2016; Susilana, Hanoum, Amelia, & Ali, 2024).

The above analysis reveals that although CTL and Student Worksheets have been explored independently, the synergy between the two in addressing numeracy literacy is still under-researched, especially in the context of fractions. The selection of CTL-based Worksheets as a learning approach among them: CTL worksheets are designed to connect academic material with real-life contexts, so that students find it easier to understand abstract concepts and apply them in practical situations (Sari et al., 2018). CTL components such as constructivist (building knowledge), questioning, and modeling are systematically integrated in the worksheet, ensuring an active and meaningful learning process (Fauziah & Nurita, 2019; Tarigan, Hill, & Simbolon, 2022). Provides a clear structure for students to explore knowledge through directed activities, such as context-based problem solving or personal reflection (Rohman, 2023; Syafitri, 2020).

The novelty of this research lies in its integrative approach, systematically combining CTL with the design of contextual based student worksheets, particularly on the topic of fractions, which has not been widely explored in previous literature. Additionally, this study develops a holistic evaluation instrument that integrates quantitative and qualitative aspects to measure numeracy literacy more comprehensively. Thus, this study not only fills the gap in teaching material design but also expands the discourse of contextual mathematics pedagogy by offering a prototype that can be adapted to other topics.

This study aims to develop a CTL-based worksheet for fraction instruction that is valid, practical, and effective in strengthening numeracy literacy among junior high school students. The development process follows an iterative framework comprising material design, expert validation, classroom trials, and product refinement. The worksheet's design integrates CTL principles to foster students' conceptual understanding, ensure its validity through empirical validation and field testing, and assess its effectiveness in improving numeracy skills.

Methods

This study uses the Design Research method with a focus on the development of educational products in the form of CTL-based Student Worksheets (Tessmer, 1994, 2013). The research stages consist of two main phases: preliminary study (needs analysis and product design) and prototype development that adopts Tessmer's formative evaluation model (Figure 1). In the prototype phase, repeated evaluations are carried out through self-evaluation, expert review, one-to-one testing, small groups, and field tests to refine the product based on input at each stage. This approach ensures that the

resulting product not only meets the design aspects, but also the effectiveness and attractiveness in learning.

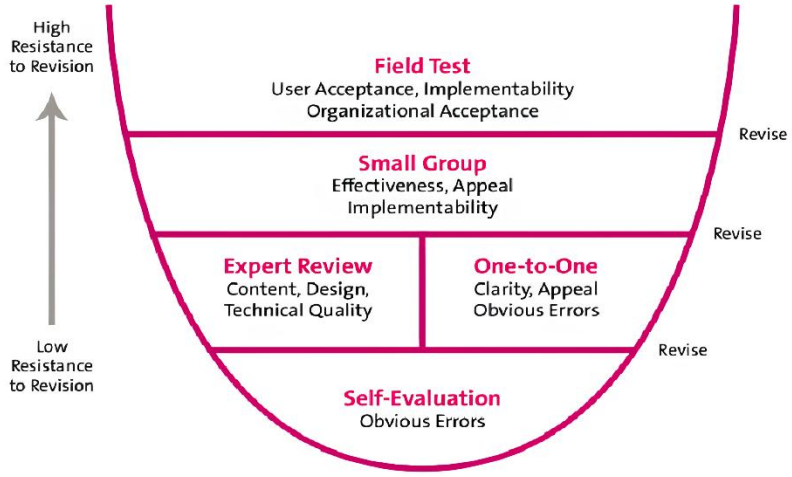

Figure 1. Tessmer's formative evaluation model

Based on Figure 1, the formative evaluation design flow in this study begins with a preliminary stage, consisting of analysis and design. In the analysis stage, researchers conduct a study of students, learning materials, curriculum, and available facilities and infrastructure to ensure the suitability of the product to user needs and learning contexts. Furthermore, the design stage produces an initial product design, such as Student Worksheets (LKPD) based on Contextual Teaching and Learning (CTL) on fraction material. This stage is the foundation for developing an initial prototype.

The prototyping stage follows a formative evaluation flow consisting of four steps: (1) Self Evaluation, where researchers conduct an independent evaluation of the initial prototype to identify deficiencies; (2) Expert Review & One-to-One Evaluation, where the product is validated by an expert (validator) and tested by 3 students to assess validity and practicality; (3) Small Group Evaluation, which is a trial in a small group (6 students) to collect collective feedback; and (4) Field Test, which is the implementation of the final product in a real learning environment to evaluate its effectiveness and impact on numeracy literacy skills. Formative evaluation aims to ensure that learning products are more effective, interesting, and relevant to the needs of students. Each evaluation stage produces a revised prototype, from Prototype I to Prototype III, which is ready to be implemented widely. This process also helps identify product weaknesses early on, correct errors, and validate the readiness of learning instruments before mass use. Thus, this model ensures the quality of development products based on systematic feedback and user context.

This research was conducted at junior high school students in the city of Palembang involving 28 grade VII students as subjects. Data collection was carried out through questionnaires, interviews, and tests to assess the validity, practicality and potential effects of student worksheets. The numeracy literacy test was developed using indicators, which include seven competencies: (1) being able to use various numbers and symbols to solve practical problems in various contexts of daily life; (2) being able to analyze information displayed in various forms (such as graphs, tables, charts); and (3) being able to interpret the results of the analysis that has been carried out to predict and draw conclusions. The test contains 3 tasks that represent each indicator of numeracy literacy. Data analysis was carried out qualitatively (describing the development process) and quantitatively (measuring the validity, practicality, and effectiveness of the product).

Validity Analysis

The validity test was conducted through an expert review involving validators (two lecturers and one mathematics teacher) to assess the content, design, and technical quality aspects of the learning media based on a 5-point Likert scale (very good to very bad). The validation instrument involved 3 media experts and material experts. Quantitative data from the validator's assessment were analyzed using the validity percentage formula: $score = \frac{f}{N} \times 100\%$, where f: frequency/number of respondents' answers, N: number of respondents), with validity criteria determined based on the final score ($score \geq 80\%$ = "very valid", $60 \leq score < 80\%$ = "valid", $40 \leq score < 60\%$ = "quite valid", $20 \leq score < 40\%$ = "less valid", $score < 20\%$ = "not valid"). In addition, qualitative data in the form of suggestions and comments from the validator were used to revise the product descriptively. This validation ensures the suitability of the material to the learning objectives, the accuracy of the design, and the technical readability of the media.

Practicality Analysis

Practicality was tested through one-to-one evaluation, small group evaluation, and field test involving students as respondents. Students filled out a questionnaire that measured the clarity, attractiveness, and ease of use of LKPD using a 5-point Likert scale. Quantitative data from the validator's assessment were analyzed using the validity percentage formula: $skor = \frac{f}{N} \times 100\%$, where f: frequency/number of respondents' answers, N: number of respondents), with validity criteria determined based on the final score ($score \geq 80\%$ = "very practical", $60 \leq score < 80\%$ = "practical", $40 \leq score < 60\%$ = "quite practical", $20 \leq score < 40\%$ = "less practical", $score < 20\%$ = "not practical"), while qualitative data in the form of student comments were used for product revision. This

stage ensures that the learning media is easy to use, interesting, and in accordance with the needs of students at various levels of ability.

Effectiveness Analysis

Effectiveness is measured at the field test stage through a learning outcome test that refers to numeracy literacy indicators, such as the ability to analyze information in graphs or tables and solve mathematical problems in real contexts. This analysis aims to evaluate the impact of using CTL-based LKPD on improving students' understanding of mathematical concepts and application skills in solving fraction problems. The test was used to assess the effectiveness of student worksheets with a minimum completeness limit (KKM) of 65, said to have a potential effect if $\geq 70\%$ of students reached the minimum completeness limit. The test result data is analyzed by calculating the average score, standard deviation, and percentage of learning completion using the formula: $NP = \frac{R}{SM} \times 100\%$, with NP: Expected value, R: Raw score obtained by students, SM: Ideal maximum score from the test) which is classified into four levels of achievement (Very Good to Less). The results of this analysis are the basis for product revision until it meets the set quality standards.

Results and Discussion

Preliminary Stage

At this stage, the researcher took two main steps: analysis and product design.

a. Analysis

The analysis was conducted through direct interviews with mathematics teachers at junior high school students in the city of Palembang. The results of the analysis showed that the school implemented the “Merdeka” Curriculum as the main framework for learning, especially in grades VII and VIII, while several other grades still used the 2013 Curriculum as a transition. In the fraction material, which is the focus of learning, many students have difficulty understanding the basic concepts of arithmetic operations, especially in the topic of adding and subtracting fractions with different denominators. The results of discussions with grade VII students revealed that this difficulty arose due to a lack of contextual understanding of the application of fractions in real situations, such as resource division or measurement. On the other hand, limited infrastructure, such as projectors that are only available in limited numbers, require teachers and researchers to design effective learning media without relying on technology. This encourages the development of student worksheets based on everyday contexts that can be accessed independently by students. By

prioritizing a practical approach and minimizing digital aids, student worksheets is designed to address learning challenges while aligning with the principles of the "Merdeka" Curriculum which emphasizes independence and relevance of the material.

b. Product Design

Based on the results of the analysis, the researcher designed teaching materials in the form of CTL-based student worksheets using the canva application. the design steps include: (1) Determination of Material, the material is focused on the concept of fractions according to student needs; (2) Visual Design, selecting a student worksheets page template, including cover design and Arranging the layout of the student worksheets contents by paying attention to technical aspects such as background, images, font size, text type, and supporting animations; and (3) Design Objectives, student worksheets is designed to be in accordance with learning objectives and has an attractive and easy-to-understand visual appearance.

Prototyping Stage

In the prototyping stage, the researcher used a formative evaluation flow. The following are the steps taken:

a. Self Evaluation

At this stage, the researcher evaluated the CTL-based student worksheets that had been designed. The evaluation was carried out together with the supervising lecturer to obtain input regarding the improvement of student worksheets. Based on suggestions and comments from the supervising lecturer, student worksheets was revised into Prototype 1. This prototype was then ready to be tested in the next stage, namely Expert Review and One-to-One. The following are the results of the evaluation at the self-evaluation stage.

Table 1. *Self Evaluation Results*

No	Evaluation Results
1.	The name box on the cover is fixed for student grouping (not individual).
2.	Student worksheets are adjusted to the steps of the CTL approach.
3.	At the constructivism stage, the story is adjusted to the context of Indonesian children. The answers are not given directly, but are made as work steps that must be answered by students. Guiding questions are also given so that students can find answers independently.

b. Expert Review and One-to-One

The expert review and one-to-one testing stages were carried out in parallel to collect input from experts and students. The data obtained were then used as a basis for refining student worksheets

into Prototype II. The results of expert validation showed that student worksheets met the eligibility standards based on the established validity indicators. Detailed validation findings are presented in Table 2.

Table 2. *Results of Expert Validator Questionnaire Sheet Analysis*

Aspect	Score	Category	Interpretation
Media	91,4%	Very Valid	Student worksheets meets visual & functionality standards.
Material (1)	56,25%	Quite Valid	Requires revision of content and material depth.
Material (2)	82,5%	Very Valid	Significant improvement after revision.
Average	**76,8%**	**Valid**	**The product is testable with minor improvements.**

Based on the validation results by experts, the student worksheets media design was assessed as very good with a very valid category, indicating that the visual and functional aspects had met the established standards. However, in the initial assessment of the material, there were shortcomings that required improvement related to the depth and relevance of the content, although after revision, significant improvements were achieved. Overall, the student worksheets product was declared worthy of being tested with a valid category, but still needed minor improvements, especially in the material aspect, to be more optimal in supporting the learning process. Thus, student worksheets has high potential as an effective learning aid if the suggested improvements can be completed. The collaboration of these two experts ensured that the student worksheets developed met the eligibility criteria both in terms of material and learning media.

Based on input from three validators (a media expert and two material experts), the researchers conducted comprehensive improvements to the CTL-based Student Worksheets. Formatting and language aspects were revised by italicizing foreign terms (*CTL*) and correcting writing errors and punctuation. Pedagogical content was refined through alignment of learning objectives with indicators, sharpening the core issues in learning activities, and integrating modeling and learning communities. Contextualization of the material was enhanced by changing the context of the second activity to a "culinary" theme (e.g., cake/pastry) to increase relevance for students. These revisions have transformed the worksheets into more coherent, engaging, and effective tools for supporting numeracy literacy, while reflecting multidisciplinary collaboration across technical, pedagogical, and contextual aspects. At this one-to-one stage, prototype I was tested on 3 students who had different levels of mathematical ability. At this stage, educators selected students who had different mathematical abilities; high, medium, and low based on student grades and activity.

Table 3. *Results of One-To-One Stage Practicality Test*

Participant Code	Total Score (Max. Score 80.)	Percentage	Category
R	63	78.75%	Very Practical
HAS	69	86.25%	Very Practical
DC	77	96.25%	Very Practical
Average	**69.67**	**87.08%**	Very Practical

The results of the one-to-one validation stage indicate that student worksheets has achieved a Very Practical level of practicality overall. Although there are variations in assessments between participants, the dominance of the "Very Practical" category in two participants indicates that student worksheets meets the eligibility standards for further implementation. The difference in scores in one participant implies the need for minor improvements in certain aspects, such as clarity of instructions or consistency of design. These findings strengthen the readiness of student worksheets as an effective learning medium to be tested in the next evaluation stage, while still considering input for final optimization.

c. Small Group

The small group stage is a continuation phase that tests Prototype II (revised results from the expert review and one-to-one stages) on 6 students in class VII-A. Participants were divided into two heterogeneous groups based on academic ability (high, medium, low). The trial was carried out for 2 teaching hours (1 hour = 40 minutes) while still implementing the scientific approach as in the previous stage. The results of the practicality questionnaire at this stage, which includes analysis per aspect, are presented in Table 4.

Table 4. *Results of the Small Group Stage Practicality Test*

Participant Code	Total Score (Max. Score 80.)	Percentage	Category
PWP	74	92.5%	Very Practical
M	74.8	93.5%	Very Practical
AUD	74	92.5%	Very Practical
RY	63	78.75%	Practical
MAP	77	96.25%	Very Practical
LAP	71	88.75%	Very Practical
Average	**72.3**	**90.37%**	Very Practical

Table 4 shows that student worksheets achieved the very practical category overall (90.37%), with the majority of participants giving a score above 85%. although one participant gave a lower score (78.75%), this only indicated the need for minor improvements in certain aspects, such as clarity of instructions or consistency of design. The high percentage of validation in the other five participants strengthens the suitability of student worksheets as a learning medium that is ready to be implemented on a wider scale. These findings support the conclusion that the student worksheets

prototype has met the practicality criteria for the next evaluation stage, with recommendations for improvement focused on aspects that received lower scores.

d. *Field Test*

The field test stage is the final stage in the formative evaluation process, where suggestions and final revisions are obtained and research is conducted on the effectiveness of the product. The results of this stage are to obtain information about the practicality of the student worksheets product that has been developed. The results of the questionnaire analysis are assessed for each aspect as shown in Table 5.

Table 5. *Results of Student Questionnaire Analysis at the Field Test Stage*

Aspects assessed	Percentage (%)	Criteria
User Acceptance	86,12 %	Very Practical
Teaching Effectiveness	95,95 %	Very Practical
Average	**91,03 %**	**Very Practical**

Table 5 shows that student worksheets achieved an overall very practical classification (91.03%), with both assessed aspects, namely user acceptance (86.12%) and teaching effectiveness (95.95%) exceeding the highest criterion threshold. The excellent achievement in the teaching effectiveness aspect confirms the suitability of student worksheets for the learning objectives, while the slightly lower (though still strong) user acceptance suggests the need for minor improvements in the usability or interface design aspects. These results provide empirical validation that student worksheets is feasible for wide-scale implementation in educational settings. The findings recommend the adoption of student worksheets in a broader curriculum context, with iterative adjustments to increase user engagement.

Table 6. *Percentage of Completion in the Field Test Stage*

Score	Category	Frequency	Percentage Completion
$0 \leq x < 65$	Not Completed	2	7,14%
$65 \leq x \leq 100$	Completed	26	92,86 %
Total		**28**	**100 %**

Table 6 shows significant effectiveness, with 92.86% of students achieving the completion criteria ($score \geq 65$). This completion level is categorized as very good, indicating that the student worksheets design successfully facilitates students' conceptual understanding and practical application. Although there are 7.14% of students who have not completed, this proportion is relatively small and can be the basis for minor improvements, such as adjusting the level of difficulty of the questions or deepening the material. These findings strengthen the potential of the CTL

approach in improving mathematics learning outcomes, especially on the topic of fractions, while recommending student worksheets as a learning tool that is worthy of being implemented widely while still considering the diversification of student needs.

Further analysis of students' answers showed that question number 1, which was designed to measure the first indicator (the ability to use numbers and symbols to solve problems in everyday life contexts), received quite good responses. One example of a student's answer shows that they are able to connect mathematical concepts to real situations, such as financial calculations or measurements. This is in line with the view that numeracy literacy is not only about the ability to count, but also about the ability to apply mathematical concepts in real-world contexts (Geiger, Goos, & Forgasz, 2015; Goos, Geiger, & Dole, 2014; Kuswanti, 2023). n other words, students not only understand mathematical procedures but are also able to use them to solve practical problems.

In addition, problem designed to measure the second indicator (the ability to analyze information in various forms) also provide important insights. Some students showed good ability in reading and interpreting data from graphs or tables, although there were some minor errors in their analysis. This emphasizes that numeracy literacy involves the ability to understand and evaluate quantitative information presented in various formats (Fadilah, Luqman, & Zahra, 2024; Supriadi, Jamaluddin, Suherman, & Komarudin, 2025). This ability is very important in today's information age, where data is often presented in visual form.

For the third indicator (ability to interpret analysis results to predict and draw conclusions), the analysis results show that most students are able to draw logical conclusions based on the data provided. However, some students still have difficulty in making accurate predictions. This is in line with the view that inferential abilities in numeracy literacy often require a deeper understanding of the relationship between variables in a problem (Ibrahim, Hardianti, Arsyad, & Fathurrahman, 2025; Ratnaya, Fitriani, Durasa, & Erlin, 2024). This will help students make accurate predictions of solutions (Hwang, Kendeou, & McMaster, 2025; Kuhn, Black, Keselman, & Kaplan, 2000). Therefore, the development of student worksheets needs to consider strengthening this aspect through reflective activities and group discussions (Puspita, Rakhmawati, & Komarudin, 2024; Wang, Chen, Lin, & Hong, 2017).

Based on the results of the analysis above, it can be concluded that the CTL-based student worksheets developed has significant potential in improving students' numeracy literacy skills. The student worksheets design that integrates everyday life contexts, data analysis activities, and

interpretation tasks helps students develop skills that are relevant to the needs of the 21st century (Marshel & Fauzi, 2021; Mirza, Pasaribu, & Simarmata, 2024; Puspita, Masykur, Eko Saputro, & Komarudin, 2022). However, the evaluation results also indicate the need for further improvement, especially in supporting students who have difficulty in predicting or drawing conclusions based on data. Thus, the revision of this prototype II will be the basis for the development of prototype III, which will then be tested further at the field test stage.

Conclusion

This study produced student worksheets based on CTL on fraction material that was proven to meet the criteria of valid, practical, and effective. The validity of student worksheets is supported by expert assessments stating that the media design and material content have met the established standards. In addition, student worksheets is also considered practical because it is easy to apply in the learning process and can be used by students well. The effectiveness of student worksheets can be seen from the learning outcomes of students who show very good conceptual understanding and a high level of learning completion. These results indicate that student worksheets is able to significantly improve students' understanding of fraction material.

These findings provide important implications for scientific literature by proving the effectiveness of implementing the CTL approach in mathematics learning, especially on fraction material which is often considered difficult. The results of this study support previous findings that contextual learning can improve student motivation and learning outcomes. As a recommendation, student worksheets can be developed for other materials in mathematics or other subjects, involving more respondents from various schools to expand the generalization of the results, and integrating digital technology to increase interactivity and relevance to current developments.

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