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Development of CTL-Based Dayak Dance Puzzle Media to Improve Engagement and Learning Outcomes of LCM for Madrasah Ibtidaiyah

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Abstract

This study addressed the low engagement of elementary students in learning the Least Common Multiple (LCM) by developing CTL-based Dayak Dance Puzzle Media supported by Factor Trees. The study aimes to produce learning media that are valid and practical, as well as to examine their effectiveness in improving students' engagement (Cognitive, Affective, Social, Motoric) and learning outcomes. The intervention specifically enhanced students' LCM learning outcomes through the ADDIE development model. The media incorporated Dayak cultural elements and manipulative puzzle activities to make abstract mathematical concepts more concrete and meaningful for MI students. This research used a Research and Development (R&D) approach. The analysis stage identified learning problems, student needs, and characteristics of the LCM material. The design stage involved creating the puzzle layout, arranging Dayak Dance images, integrating Factor Trees, and aligning components with CTL principles. The development stage included media production, expert validation, and revisions. Implementation was conducted with 21 fifth-grade Madrasah Ibtidaiyah (MI) students, followed by evaluations using comprehension tests, observations, questionnaires, and documentation. The findings showed that the CTL-based puzzle media effectively improved students' engagement and understanding. Prerequisite tests confirmed normality and homogeneity, allowing accurate application of the paired t-test. The paired t-test result (sig. 0.000 ≤ 0.05) showed a meaningful difference between pre-test (62.19) and post-test (83.10) scores, while the N-Gain value of 0.5585 indicated a moderately effective improvement. The media developed were proven to be valid and practical to use in MI classrooms. Furthermore, the results showed that the media is effective in increasing student engagement in the Cognitive, Affective, Social, and Motor aspects, as well as improving their learning outcomes.

Keywords: *: Dayak Dance Puzzle; Factor Tree; Engagement-CTL; Development; Madrasah Ibtidaiyah.*

INTRODUCTION

Mathematics education at the elementary school level focuses not only on mastering concepts but also on the process of discovery. Mathematics equips students

with essential arithmetic skills such as subtraction, addition, division, and multiplication, which serve as foundational competencies for solving daily-life problems (Safari & Faradila, 2024). However, current mathematics learning in many elementary schools remains teacher-centered. A national survey by Kemdikbud (2023) showed that 62% of elementary mathematics lessons are still dominated by lecturing, limiting opportunities for students to think critically and explore concepts independently. Meanwhile, modern mathematics learning requires active student participation in reasoning, problem-solving, and conceptual exploration (Siregar & Scholar, 2025).

Mathematics in elementary school plays a crucial role in developing students' logical, systematic, critical, and creative thinking. One of the essential topics taught in Grade V is the Least Common Multiple (LCM), which becomes a prerequisite for understanding fractions, ratios, and more advanced mathematical operations(Mufida et al., 2022). In reality, many students face difficulties determining LCM because the material is abstract and requires careful identification of factors and multiples. A study by Puspendik (2022) reported that 48% of Grade V students failed to correctly determine LCM in diagnostic assessments, indicating conceptual weaknesses rooted in insufficient learning support. Conventional teaching methods—dominated by lectures and repetitive written exercises further contribute to low student engagement.

Student engagement is a critical factor influencing learning success because it relates to motivation, attention, and active participation. Low engagement results in students having difficulty developing deep conceptual understanding. To address this issue, teachers need learning media that are not only innovative and interactive but also capable of transforming abstract mathematical concepts into concrete experiences. Many existing media still rely heavily on verbal explanations and do not effectively build meaningful learning connections. According to Evy Ramadina (2022), well-designed learning media can clarify messages, overcome sensory limitations, and increase student motivation.

One creative medium that can address this learning challenge is the Dayak Dance Puzzle assisted by Factor Trees. The Dayak Dance Puzzle is an educational tool that combines visual, logical, and kinaesthetic elements. Students assemble puzzle pieces based on the results of LCM calculations, while the factor tree method helps them systematically identify number factors. This approach introduces gamification into mathematics learning, making the process both engaging and cognitively stimulating (Daryanti, 2025) . Through this method, students not only compute LCM but also

experience satisfaction as they complete a meaningful visual product.

The development of the Dayak Dance Puzzle using the Factor Tree was based on the need for elementary school mathematics learning to provide concrete, contextual, and relevant media to students' lives. This media not only helps visualize the concepts of Factors and LCM/GCF but also integrates local cultural elements as a form of culturally responsive learning. This media aligns with the characteristics of the Elementary School/Islamic Elementary School Curriculum, which emphasizes active, meaningful learning, and oriented toward students' real-life experiences. Both the 2013 Curriculum and the Independent Curriculum emphasize that mathematics learning must develop conceptual understanding through manipulative activities and visual representations. The use of puzzles helps students build concepts through problem-solving activities, while factor trees facilitate systematic mathematical representation (Anwar & Jannah, 2023) . In thematic learning, this media can connect mathematics competencies with local Dayak culture, which is generally included in social studies or arts and culture. This cross-subject integration supports a holistic learning approach, enriches the learning context, and strengthens students' character and cultural identity. Thus, this media is relevant to the curriculum's goal of fostering both academic competency and cultural awareness.

The integration of Dayak dance elements into puzzles is based on the Culturally Responsive Teaching (CRT) theory proposed by (Gay, 2016) . Gay emphasized that learning will be more effective if students' culture, values, and experiences are accommodated as part of the learning process (Justice, 2016) . When students see their culture represented in the learning material, their motivation, sense of belonging, and cognitive engagement increase. From a media theory perspective, the use of puzzles and factor trees supports the principles of visualization, interaction, and active involvement. Manipulative-based media—such as puzzles—have been shown to help students grasp abstract concepts more easily because they enable them to organize, analyse, and connect information concretely. By incorporating visuals of Dayak culture, this media not only serves as a learning aid but also as a means of strengthening cultural identity and appreciation. Through the combination of manipulative media, mathematical representation, and local culture, the Dayak Dance Puzzle, using the Factor Tree, is pedagogically, psychologically, and culturally relevant for elementary school students.

The integration of the Dayak Dance Puzzle supported by Factor Trees is expected to increase student engagement significantly. (Zahroh et al., 2024) explained

that engagement can be enhanced through learning activities that are challenging, enjoyable, and collaborative. This puzzle media allows students to engage cognitively (calculating and reasoning), affectively (feeling motivated and enthusiastic), and psychometrically (manipulating puzzle pieces). Thus, learning becomes holistic rather than purely cognitive. Previous studies also demonstrate the positive impact of game-based media in mathematics learning. Veronica (2019) found that puzzle-based learning has increased students' interest in mathematics by over 40%. Similarly, (Tondang et al., 2024) reported that factor-tree-assisted media has improved student accuracy in determining LCM and GCD by 35% compared to conventional methods. These findings support the potential of combining visual and game-based strategies to enhance learning effectiveness (Veronica, 2019) .

Based on the issues and evidence above, the researcher is interested in developing CTL-based Dayak Dance Puzzle media aimed at improving MI students' engagement and understanding in LCM learning. This study is expected to provide an alternative learning media that is creative, culturally relevant, and effective in increasing student engagement, making mathematics learning more meaningful, enjoyable, and easier to understand

METHODS

This study applied a Research and Development (R&D) method using the ADDIE development model, which consisted of five stages: Analysis, Design, Development, Implementation, and Evaluation (Aisyah, 2024). This model was selected because it offered a systematic, structured, and flexible framework for producing effective instructional media. Through the ADDIE process, the researcher was able to identify learning needs, design appropriate solutions, develop the product, conduct trials, and carry out continuous revisions until the media is ready for classroom use. The media developed in this study was validated by Jasiah, M.Pd., a lecturer at UIN Palangka Raya and the Head of the MPI Study Program. The validation results confirmed that the media was feasible, relevant, and appropriate for instructional application in MI classrooms. (Ade Rahayu, 2025).

In the analysis stage, the researcher identified learning problems in Grade V of Madrasah Ibtidaiyah by conducting initial classroom observations, interviewing the mathematics teacher, and reviewing existing lesson plans. Low student engagement was measured using an observation checklist that recorded indicators such as student

participation, attention, responsiveness, and involvement during activities related to the Least Common Multiple (LCM). These data confirmed that students tend to be passive, easily distracted, and less motivated during LCM learning. The design stage included planning the structure, features, and learning flow of the instructional media. At this stage, the researcher selected a culturally based approach by integrating Dayak Dance Puzzle images as the main visual component and combining them with Factor Trees to support conceptual understanding. The researcher also prepared storyboards, puzzle layouts, learning objectives, and CTL-based activity steps to ensure alignment with curriculum standards. The development stage consisted of producing the media prototypes, creating visual puzzle elements, and assembling them with the Factor Tree components. The researcher observed how students interacted with the media, collected engagement data using observation sheets, and recorded student responses to determine the practicality and attractiveness of the developed material. The evaluation stage included analysing the results of the implementation, reflecting on the strengths and weaknesses of the media, and conducting final revisions.

The implementation stage was carried out by applying the media in a Grade V class consisting of 21 students, during which the researcher observed student engagement, administers a conceptual understanding test, and distributed student response questionnaires to evaluate their perceptions of the learning media. This stage also included the final evaluation process, which was conducted to determine the media effectiveness based on the improvements of student engagement and learning outcomes (Trisnawati et al., 2025). The effectiveness analysis of the media was carried out using the Paired Sample T-Test to compare the mean scores of the pre-test and post-test, aiming to determine whether there was a significant improvement in students' understanding. Before conducting the t-test, prerequisite testing was performed through the Shapiro–Wilk normality test. The results showed that the pre-test data had a Sig. value of 0.132 ≥ 0.05 and the post-test data had a Sig. value of 0.087 ≥ 0.05, indicating that both datasets were normally distributed and fulfilled the assumptions required for parametric analysis.

Data were collected from 21 students using two techniques by observation and LKPD scoring. Observation was used to record students' engagement during learning, including participation, attention, and activeness, while LKPD scores from the Dayak Dance Puzzle activities measured students' conceptual understanding of LCM. These data were then prepared for effectiveness testing, where the pre-test and post-test results served as the primary basis for evaluating whether the media led to significant

improvements in learning outcomes. Descriptive analysis was later used in the discussion section to support and interpret the findings

RESULTS AND DISCUSSION

Results

The results of this study are presented according to the five stages of the ADDIE development model to show the flow of media development and its impact on learning:

1. Analysis Stage

In the analysis stage, it was found that students showed low engagement when learning the LCM topic because learning activities were still dominated by lectures. The needs analysis indicated that students required concrete, visual, and contextual media to understand abstract mathematical concepts. This finding aligns with (Studi et al., 2017), who states that appropriate media based on student characteristics can increase attention, motivation, and conceptual understanding. Furthermore, the abstract nature of LCM material necessitates the use of visual aids to support students' thinking processes.

2. Design Stage

The design stage involved aligning the media with the Learning Outcomes (CP) and CTL principles. The visual puzzle layout, cutting structure, and integration of the Factor Tree were designed to support students in constructing their own understanding of the LCM concept.

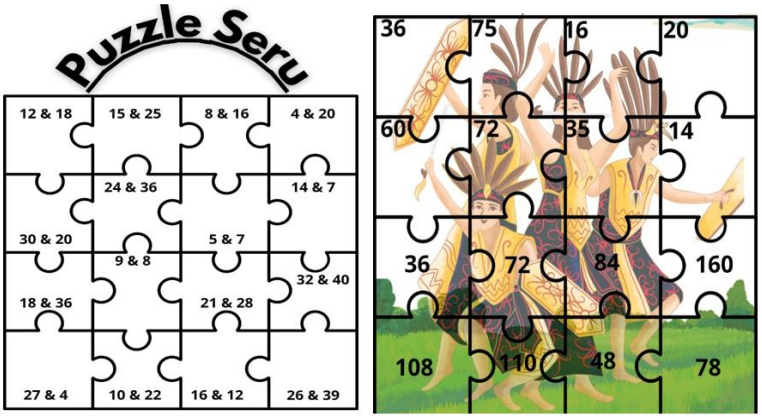

Figure I. Design of LCM Puzzle Worksheet of the Dayak Dance

A representative diagram/flow illustration was also included to depict the design logic and the relationship between the puzzle components, the cultural elements of the Dayak Dance, and the mathematical structure of the Factor Tree, ensuring that the development process was clearly visualized and aligned with the intended learning objectives. This approach is consistent with (Dan, n.d.; Keseimbangan et al., n.d.) view that instructional design should connect new knowledge with real-life student experiences to achieve meaningful learning. The colorful, tactile puzzle media and the culturally relevant Dayak dance context captured students' attention and made learning meaningful. Successfully finding factor pairs and assembling the puzzle strengthened confidence and cognitive understanding, while completing the Dayak dance picture provided satisfaction from both achievement and collaboration. Students not only knew the results but also fully experienced the learning process.

Figure 2. Design of KPK tree results

3. Development Stage

During the development stage, the media and LKPD were produced and validated by a single expert validator. The validator provided positive assessments across all criteria, indicating that both the LKPD and the learning media were feasible and of good quality. Although the validator confirmed that the products were suitable for use, several minor revisions such as adjustments to color, image proportion, and clarity of instructions were recommended to enhance usability. This validation process is in line with (Purwanto, 2023), who emphasizes that in R&D, expert review is essential to ensure that the developed product is systematically structured, feasible, and optimal for instructional implementation.

4. Implementation

The implementation stage was carried out in a Grade V class with 21 students. The use of the Dayak Dance Puzzle and Factor Tree created a more active, collaborative, and enjoyable learning environment. Students demonstrated increased engagement by discussing, asking questions, and assembling the puzzle pieces. These findings are consistent with (Ilyas, 2018), who emphasizes that manipulative and collaborative activities can enhance students' participation and interest in mathematics learning.

5. Evaluation Stage

In the evaluation stage, observational data and LKPD scores were analyzed descriptively. The results showed that student improved engagement and conceptual understanding after using the media. Both formative and summative evaluations were conducted, following (Trisnawati et al., 2025), who state that evaluation in media development must assess both the learning process and outcomes to determine media effectiveness.

Tabel 1. Paired Samples Statistics

Pair	Test type	Mean	N	Std. Deviation	Std.Error Mean
Pair 1	Pre Test	62.1805	21	3.707970	.80952
Pair 2	Post Test	83.0952	21	4.02374	.87805

The comparison of pre-test and post-test scores was conducted on the same group of students, so the appropriate analysis was the Paired Sample T-Test. The use of an independent t-test was not required because there was no control group for comparison. Therefore, the increase in post-test scores compared to pre-test scores could be directly analyzed to assess the effectiveness of the learning media.

Table 2. Paired Samples Correlation

Pair	Variabel	N	Cprrelation	Sig
Pair 1	Pre test & post test	21	.970	.000

There was a very strong and significant correlation between pretest and posttest scores. These results indicated that the pre- and post-treatment scores had a consistent pattern, which supported the validity of the comparison of the effectiveness of the treatment on students.

Tabel 3. Paired Samples Test

Variable	Mean Difference	Std. Deviation	Std. Error Mean	95% CI Lower	95% CI Upper	t	df	Sig. (2-tailed
Pretest & postest	-20.90476	.99523	*0.21718*	*-21.35778*	*-20.45174*	*-96.26*	*20*	*000*

Based on the data, it was known that the sig value (2-tailed) was 0.000≤0.05, so we could conclude that there was a real difference between the mathematics learning outcomes in the pre-test and post-test data.

Tabel 4. Descriptive Statistics of N-Gain Scores

Variable	N	Minimum	Maximum	Mean	Std.deviation
NGain_score	21	.44	.67	.5585	.06453
NGain_persen	21	44.44	66.67	55.8513	6.45317
Valid N (listwise)	21				

Based on the results of the paired sample test and the N-Gain calculation, it was evident that the implemented learning media had a positive impact on students' understanding. The mean N-Gain value of 0.5585, or 55.85%, indicated that the improvement in students' understanding fell into the medium category, meaning that the treatment provided was practically effective. This aligned with the paired sample test results, which showed a significant difference between pre-test and post-test scores. Therefore, it could be concluded that the learning media was able to enhance students' learning outcomes both statistically and in terms of the practical magnitude of the improvement in their understanding.

Therefore, the Paired Sample T-Test was appropriate for use in this study. The Paired Samples Statistics indicated that the mean pre-test score was 62.19, while the mean post-test score increased to 83.09. The correlation between the two tests was very strong (r = .970, p = .000), showing a consistent pattern of improvement. Furthermore, the Paired Samples Test revealed a mean difference of -20.90 with a t-value of -96.257 and a Sig. (2-tailed) value of 0.000 ≤ 0.05. These results confirmed a significant difference between the pre-test and post-test scores, demonstrating that the media had a substantial positive effect on student learning outcomes. Additionally, the N-Gain

calculation showed an increase categorized as effective, further reinforcing that the learning media significantly improved students' understanding of the material.(Trisnawati et al., 2025).

DUSCUSSION

Analysis of Contextual Teaching and Learning (CTL) Strategy Implementation

The implementation of the Contextual Teaching and Learning (CTL) strategy in teaching Least Common Multiple (LCM) using the Dayak Dance Puzzle Images and Factor Trees is carried out in an integrated and sequential manner. In the constructivism stage, students assemble puzzle pieces to form the Dayak Dance image and connect the emerging patterns with the numbers in the LCM problems, allowing them to build understanding independently. The inquiry process takes place when students explore the factors of numbers through the Factor Tree to identify the LCM systematically. Learning community activities emerge as students work collaboratively in groups to complete the puzzle and construct the Factor Tree while discussing and helping one another. The teacher also provides modeling by demonstrating how to create a Factor Tree before students perform it independently. After this activity, students engage in reflection by writing down the steps they followed and the learning experiences they gained. Finally, authentic assessment is carried out through process-based evaluation, including student involvement in assembling the puzzle, the quality of group discussions, and the accuracy of their constructed Factor Trees. Through this CTL application, the learning process becomes more meaningful, active, and relevant for students.

Analysis of Student Engagement in the Learning Process

1. Cognitive Engagement

Cognitive engagement is an essential aspect of learning, especially in mathematics education, which requires conceptual understanding and reasoning skills (Safari & Faradila, 2024). Based on the observations, students' cognitive engagement is clearly visible when they are involved in thinking, calculating, and analysing problems through the use of the puzzle media. At this stage, students are not merely receiving information passively; instead, they actively build understanding through a structured thinking process.

In solving problems related to the Least Common Multiple (LCM), students use the factor tree method as a tool to break numbers down into their prime facto. This stage requires analytical skills, as students need to determine which numbers are prime factors and how to decompose them correctly. To find the LCM of 10 and 15, for example, students first break down 10 into 2 × 5 and 15 into 3 × 5. They then identify the common factor, which is 5, and combine it with the remaining factors to determine the correct LCM, which is 30. This process demonstrates that students rely on conceptual knowledge rather than simply memorizing formulas. They have to understand the relationship between prime factors, multiplication, and multiples. In other words, this learning activity activates conceptual understanding, which is stronger than mere procedural understanding (Kharismayanda et al., 2025).

An interesting finding from the observations is that each student uses different strategies when performing calculations. Some write the number factors on small pieces of paper before arranging them on the factor-tree board. Others use finger counting to ensure the accuracy of their factors. Several students engage in active discussion with their group members to reach an agreement before placing the puzzle pieces. This variety of strategies indicates that the learning process offers cognitive flexibility, allowing students to choose the thinking approach that best suited their individual learning styles (Anjarweni et al., 2024).

Based on the Dayak Dance Puzzle Worksheet, the teacher's role shifts from being the main instructor to becoming a learning facilitator. The teacher provides scaffolding based on students' needs, offering guidance only when difficulties arise in breaking down numbers into factors, and gradually withdraw support to enable independent problem-solving (Utami, 2024). Through the puzzle activity, students engage in systematic thinking: correct arrangement depends on accurate LCM calculations, prompting them to reflect, review, and correct errors (Sape & Syamsuddin, 2025).

Reflective activities strengthen conceptual understanding, allowing students to explain why certain values were the LCM and connect factors to the calculation's purpose, indicating logical reasoning and promoting learner autonomy. Students actively discover answers rather than relying solely on the teacher, enhancing meaningful learning and academic self-confidence. These cognitive processes are supported by group interactions, where discussions during puzzle-solving allow students to present arguments, receive feedback, and refine thinking, aligning with

cooperative learning theory (Jannah, 2025). Thus, students' cognitive engagement in learning using the Dayak Dance Puzzle Picture media and Factor Tree can be summarized as a learning process that emphasizes (1) Conceptual understanding rather than memorization. (2) Independent and flexible thinking strategies. (3) Reflection and self-correction (metacognition). (4) Collaboration in constructing shared knowledge. (5) Teacher guidance in the form of scaffolding rather than domination. All of these aspects show that the learning activity has created an active, meaningful environment oriented toward the development of higher-order thinking skills (Sucipto, 2017). In other words, the puzzle media not only adds enjoyment to the learning process but also plays an important role in enhancing students' cognitive abilities in understanding mathematical concepts, particularly LCM.

2. Affective Engagement

Affective engagement in learning plays an important role in the success of the learning process because this aspect is related to students' feelings, attitudes, and interests during the activities. Based on the observations, most (Paputungan & Paputungan, 2023). students show expressions of joy, enthusiasm, and high motivation throughout the lesson. The classroom atmosphere is lively and supportive, with students encouraging each other through applause and cheers when placing puzzle pieces correctly. The teacher's praises boost motivation, confidence, and a sense of value in their contributions, aligning with Keller's ARCS model of learning motivation (Attention, Relevance, Confidence, Satisfaction(Manusia et al., 2019)

The use of this media makes it easier for students to understand the process of breaking numbers down into their prime factors in a visual and systematic manner. Through the display of the factor tree, students can clearly see the relationships between numbers, allowing them not only to memorize the calculation steps but truly understand the underlying concept in determining the LCM. This media also helps minimize errors because the branches of the factor tree are presented sequentially, guiding students in comparing prime factors and determining the smallest multiple accurately. In addition, using the factor-tree media has encouraged students to think more critically and systematically, as well as has increased their independence in solving mathematical problems in a gradual and logical way.

The affective engagement observed is particularly significant among students who are usually passive in mathematics learning (Arif & Mahmudah, 2022). Some

students who typically lack confidence, tend to remain silent, or are afraid of making mistakes, appear more willing to ask questions, answer the teacher's questions, express their opinions, and even take an active role in assembling the puzzle. They no longer feel "threatened" by the difficulty of mathematics because the lesson is presented in a more friendly, humanistic, and approachable way. Thus, this enjoyable learning experience has helped enhance their self-esteem that is, a positive belief in their own abilities. Students' intrinsic motivation also develops naturally, as they learn not because they are forced to, but because they enjoy the process.

Based on these findings, it can be concluded that affective engagement is an important aspect that greatly contributes to the success of learning using puzzle media supported by the factor tree. This learning approach not only improves students' cognitive understanding of the LCM concept but also creates a positive psychological learning environment, boosts confidence, strengthens social interaction, and encourages students to enjoy learning as a meaningful experience. In other words, mathematics learning becomes more lively, humanistic, and closely connected to students' real-world experiences, providing a long-term positive impact on their attitudes and learning motivation in the future.

3. Social Engagement

Social engagement in learning is a crucial aspect because it relates to how students interact, communicate, and collaborate throughout the learning process (Fitriyanti & Hidayati, 2025). In learning activities that puzzle media is applied, this social engagement is highly evident. The activities are carried out in small groups, giving each student the opportunity to contribute according to the roles they agree upon. Some students are responsible for calculating number factors, some for writing the results on the worksheet, and others for arranging the puzzle pieces to form the correct image. This division of roles not only train responsibility but also instil a sense of ownership toward the group's results. Students feel that the success of the group is a shared success, and similarly, challenges that arise are collective challenges to overcome.

The teacher notes an increase in collaboration among students during the activity. Students who grasp the LCM and factor-tree concepts more quickly naturally help those who are still confused. This mutual assistance occurs spontaneously without explicit instruction from the teacher. For example, one student said to a peer, "Let's use the factor-tree method first it's easier." This remark reflects collaborative awareness

that understanding can be gained not only from the teacher but also from peer interaction. In other words, collaboration-based learning facilitates peer teaching, where students think other students using simpler and more familiar language. The learning environment created during this activity is democratic and cooperative. This aligns with the principles of collaborative learning, a learning model that emphasizes cooperation, mutual assistance, and shared responsibility in achieving group goals. Through group work, students learn to appreciate others' opinions, express their ideas politely and clearly, and listen attentively. They also learn to accept differences in abilities and thinking pace within the group. Students who understand more quickly do not dominate, and those who learn more slowly do not feel left behind. These social interactions contribute significantly to fostering empathy, tolerance, and mutual respect—values that are essential components of character education, especially in elementary school, where shaping attitudes and personality is just as important as academic achievement (Dyah Aryani et al., 2025).

Through this activity, students not only learn mathematics but also learn to build positive social relationships. They practice solving problems together, making group decisions, and resolving minor conflicts that might arise during the activity. This is particularly important because the ability to collaborate is a 21st-century skill students must acquire from an early age. Learning activities such as this transform the classroom into more than just a space for receiving knowledge; it becomes a social environment where students learn to become individuals capable of interacting constructively and healthily with others. Thus, social engagement in learning not only strengthens academic success but also contributes to shaping students' character to be adaptive, communicative, and empathetic.

4. Motoric Engagement

Motor engagement in learning refers to the physical activities performed by students during the learning process. In this learning activity, motor engagement is clearly visible because students are not merely sitting and listening to the teacher's explanation; instead, they move, touch, arrange, and manipulate the learning media in the form of puzzle pieces and factor trees. These physical activities involve coordination between hands, eyes, and thought simultaneously. Movements such as picking up puzzle pieces, checking shape compatibility, attaching the images to the board, and correcting misaligned positions provides an active and dynamic learning experience (Adatul'aisy et al., 2023).

Beyond offering an enjoyable learning experience, these motor activities also help students maintain attention and concentration for longer periods. There are no signs of boredom, fatigue, or lack of interest throughout the activity. On the contrary, the activities that requires students to stand, move, and collaborate in groups make the classroom atmosphere lively and full of positive energy. This shows that light physical activities can increase brain stimulation, making the thinking process more active and focused. Students who are previously passive and quiet become more engaged and actively participate in this activity. Motor engagement also plays an important role in transforming abstract mathematical concepts into more concrete and understandable forms (Wulansari et al., 2022). When students attach puzzle pieces according to the LCM results, they calculate using the factor tree, they indirectly visualize the relationship between numbers and real forms. This process is known as concretization, which is the transformation of abstract concepts into real experiences through physical activity. Thus, students not only memorize the LCM formula but also understand how the concept is applied in visual and practical forms. For example, students hand puzzle pieces to one another, adjust the board's position, or help friends who have difficulty attaching pieces. Such motor interactions strengthen social skills and a sense of care. They learn to work harmoniously, coordinate movements, and adjust their tasks to produce a complete and correct puzzle picture. Thus, motor engagement not only supports physical and cognitive development but also students' social–emotional growth.(Syifa Kamilah Sophian et al., 2025)

The results of this study indicate that the implementation of the Dayak Dance Puzzle media supported by the Factor Tree successfully has increased the engagement of fifth-grade students in learning the Least Common Multiple (LCM) concept. Student engagement scores, measured through observation, show a noticeable improvement in attention, participation, and collaboration. Learning outcomes has also increased, as shown by the results of the paired-samples t-test: the average pre-test score was 62.19, while the post-test average rose to 83.10, representing a significant increase of 20.91 points. The correlation test between the pre-test and post-test scores showed a value of 0.970 with a significance level of 0.000, indicating a very strong positive relationship and confirming that the improvement is not coincidental. Learning that is initially abstract and difficult becomes more concrete, interesting, and accessible because students are directly involved in manipulative and exploratory activities. The use of puzzle media creates an active learning experience in which students not only listen and take notes but also think, interact, discuss, and construct their own understanding.

These findings demonstrate that the use of Dayak Dance Puzzle Images media, supported by Factor Tree and contextual teaching strategies, is effective in improving students' mathematics learning outcomes, particularly in understanding the LCM concept.

This transformation contrasts sharply with conventional teaching methods dominated by lectures and exercises, which often make students passive and less motivated. These findings are consistent with student-centered learning, which positions students as active subjects in the learning process. In this study, students engage in higher-order thinking processes such as analysis, synthesis, evaluation, and reflection. They not only calculate the LCM but also verify their results by matching puzzle pieces, allowing inquiry and self-correction—essential aspects of mathematics learning. The teacher provides assistance only when necessary, in accordance with Vygotsky's scaffolding approach (Damanik et al., 2025). In addition, CTL components such as questioning are presented through guiding questions posed by the teacher, while learning community emerged through natural collaboration in group work. After using the puzzle media, students have demonstrated increased enthusiasm, confidence, and positive perceptions of mathematics. Even previously passive students begin speaking up and sharing their ideas (Rohyana et al., 2025). From the teacher's perspective, the puzzle media is practical, easy to use, and effective for classroom management. Although it requires initial preparation, the benefits are substantial. Teachers can shift their role from information providers to facilitators, in line with 21st-century teaching demand. With the support of authentic assessment, teachers can evaluate both learning processes and outcomes more comprehensively.

Overall, the use of the Dayak Dance Puzzle media supported by the Factor Tree, combined with contextual teaching strategies, proves to be an effective innovation for enhancing elementary students' engagement in mathematics learning. According to Piaget's cognitive development theory, puzzles facilitate the representation of the LCM concept by allowing students to manipulate pieces and visualize abstract mathematical relationships, helping them construct knowledge through concrete operational thinking. The Factor Tree further supports conceptual scaffolding by breaking down complex problems into smaller, manageable steps, guiding students from understanding prime factors to calculating the LCM. The blend of local culture, manipulative activities, group collaboration, and CTL principles results in meaningful, enjoyable, and impactful learning. This media does not require advanced technology, is relatively easy to develop, and has strong potential for application across various topics and school contexts

CONCLUSION

Based on the research objectives stated in the abstract, it can be concluded that the development of CTL-based Dayak Dance Puzzle media supported by Factor Trees successfully has improved the engagement and learning outcomes of MI students in the Least Common Multiple (LCM) material. The Paired Sample T-Test results showes a significant difference between the pre-test scores (62.19) and post-test scores (83.10) with a significance value of 0.000 ≤ 0.05, while the N-Gain calculation of 0.5585 (55.85%) indicates a practically effective improvement in students' Learning outcome. Observations of student engagement have revealed increases in cognitive, affective, social, and motor domains, with students more actively thinking, discussing, collaborating, and manipulating the media, making learning more meaningful and enjoyable. The integration of Dayak cultural elements and CTL strategies has made the abstract LCM concepts more concrete, supporting character development, cultural awareness, and mathematics learning relevant to students' lives. Thus, this media has been proven effective both statistically and practically, while also offering a creative, contextual, and culturally based alternative for MI classroom learning.

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