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DEVELOPMENT OF INQUIRY-BASED DIGITAL WORKSHEET TO IMPROVE MATHEMATICAL THINKING ABILITY

Chamila Putri Audina[1], Ely Susanti[2]*, Nyimas Aisyah[3]

[1,2,3] Pendidikan Matematika, Universitas Sriwijaya, Palembang, Indonesia
*Corresponding author.
E-mail: chamilaputri119@gmail.com [1)]
ely_susanti@fkip.unsri.ac.id [2*)]
nyimas.aisyah@fkip.unsri.ac.id [3)]

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Abstract

One of the mathematical abilities that schools are expected to develop is students' mathematical thinking ability. However, many students still struggle in this area due to the use of learning methods not aligned with students' characteristics and learning environments. These methods often lack opportunities for student interaction and fail to accommodate individual learning levels, resulting in limited engagement and development of higher-order thinking. This condition indicates the need for innovative learning approaches that promote active involvement, interaction, and reasoning. Inquiry-based learning, supported by digital worksheets, is one such approach that can help improve students' mathematical thinking. This research aims to develop valid and practical inquiry-based digital worksheets on cubes and beams for grade 8 students and to examine their potential to enhance their mathematical thinking ability. The study consists of two stages: the preliminary stage, which involves the development of the worksheet concept and design, and the prototyping stage, which includes self-evaluation, expert review, one-to-one, small group, and field testing. Validity data obtained from expert reviews show an average score of 87%, categorized as very valid, while practicality data yield an average score of 79%, categorized as practical. The students' work on the tasks indicates a high level of mathematical thinking, with 79.3% categorized as very good, 10.3% as good, 3.4% as sufficient, and 6.9% as less. Interview results based on mathematical thinking indicators show that specialization is the most frequently demonstrated indicator, while conjecture appears the least. These findings suggest that inquiry-based digital worksheets can potentially support the development of students' mathematical thinking.

Keywords: Digital; inquiry; mathematical; thinking; worksheet.

Abstrak

Salah satu kemampuan matematis yang diharapkan dapat dikembangkan di sekolah adalah kemampuan berpikir matematis siswa. Namun, banyak siswa masih mengalami kesulitan dalam mengembangkan kemampuan ini akibat penggunaan metode pembelajaran yang tidak sesuai dengan karakteristik siswa dan lingkungan belajarnya. Metode tersebut sering kali tidak memberikan ruang interaksi antarsiswa dan tidak disesuaikan dengan tingkat kemampuan siswa, sehingga keterlibatan dan pengembangan kemampuan berpikir tingkat tinggi menjadi terbatas. Kondisi ini menunjukkan perlunya inovasi pembelajaran yang mendorong keterlibatan aktif, interaksi, serta penalaran siswa. Pembelajaran berbasis inkuiri yang didukung dengan lembar kerja digital merupakan salah satu pendekatan yang berpotensi meningkatkan kemampuan berpikir matematis siswa. Penelitian ini bertujuan untuk mengembangkan lembar kerja digital berbasis inkuiri pada materi kubus dan balok untuk siswa kelas VIII SMP yang valid dan praktis, serta mengetahui potensi pengaruhnya dalam meningkatkan kemampuan berpikir matematis siswa. Penelitian ini terdiri dari dua tahap, yaitu tahap pendahuluan yang menghasilkan konsep dan desain lembar kerja, serta tahap prototyping yang meliputi evaluasi diri, tinjauan ahli, uji perorangan, uji kelompok kecil, dan uji lapangan. Data validitas diperoleh dari hasil tinjauan ahli dengan skor rata-rata 87% (kategori sangat valid), sedangkan data kepraktisan memperoleh skor rata-rata 79% (kategori praktis). Hasil pengerjaan siswa menunjukkan kemampuan berpikir matematis yang tinggi, dengan 79,3% siswa berkategori sangat baik, 10,3% baik, 3,4% cukup, dan 6,9% kurang. Berdasarkan wawancara yang mengacu pada indikator berpikir matematis, indikator yang paling sering muncul adalah spesialisasi, sedangkan indikator yang paling jarang muncul adalah

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dugaan (conjecture). Temuan ini menunjukkan bahwa lembar kerja digital berbasis inkuiri berpotensi mendukung pengembangan kemampuan berpikir matematis siswa.

Kata kunci*: Berpikir;digital; inkuiri; matematis; worksheet.*

INTRODUCTION

Mathematical thinking is a fundamental skill essential for effective problem-solving. It encompasses the ability to recall and comprehend information and the capacity to analyze, synthesize, and evaluate concepts through logical reasoning (Goos & Kaya, 2020). Therefore, it is considered a core competency that all students must develop to succeed in academic settings and real-life situations. Teachers play a pivotal role in fostering this competence by designing instructional processes that offer structured guidance, meaningful learning experiences, and relevant contexts that reflect real-world applications (Pepin et al., 2017).

Furthermore, mathematical thinking involves deductive and inductive reasoning, which are used to gather, interpret, and analyze information. These reasoning processes enable students to formulate generalizations, deepen their understanding of mathema-tical concepts, and construct new knowledge (Chance et al., 2024). Since these cognitive skills are closely linked to everyday problem-solving, they are indispensable for students' success across academic domains and real-life challenges (Hačatrjana & Namsone, 2024). To ensure its development, mathematical thinking should be inten-tionally nurtured and consistently enhanced through appropriate teaching strategies, including inquiry-based learning and technology integration (Lu et al., 2025).

In the context of the digital era, learning materials must be designed not only to convey content but also to engage learners in meaningful ways. They should be interactive, relevant, and capable of providing flexible learning environments that support exploration, collaboration, and student autonomy (Alam & Mohanty, 2023; Alenezi, 2023). Therefore, teachers are expected to present innovative instructional methods that effectively use digital tools to support student learning. In addition, the imple-mentation of the independent curriculum requires teachers to create active, creative, and student-friendly learning experiences that are aligned with the evolving demands of the digital age (Alam & Mohanty, 2023).

The problem in the field shows that many students have difficulty thinking mathematically, especially in understanding the problem-solving process. This difficulty impacts their mathematics learning outcomes (Sinaga et al., 2023; Wijaya et al., 2019). One of the contributing factors is the use of inappropriate learning methods that do not align with student characteristics. Moreover, the learning environment often fails to support student interaction and rarely accommodates learning preferences that match students' levels of knowledge (Pedersen et al., 2023; Zhang & Cao, 2022).

In studying mathematics, especially in the material of cubes and beams, students must have a broad understanding of concepts, not only in the material but also in applying

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symbols or formulas in mathematics. The inquiry learning model has been proven effective in developing students' critical thinking abilities because it helps students increase their knowledge and deepen their understanding of what they are learning (Ay & Dağhan, 2023).

In today's digital era, learning materials must go beyond merely being relevant. They must be engaging and practical to create meaningful learning environments (Alakoski et al., 2024). This is particularly important considering that students are digital natives highly familiar with technology and multimedia daily. Therefore, teachers must adopt innovative teaching approaches that effectively facilitate using digital tools in learning (Susanti et al., 2025). In line with these needs, one effective solution is using digital worksheets, which are interactive and technology-based learning aids intended to support both independent and collaborative learning. These worksheets allow material to be presented in various formats, such as text, images, and videos, and they also provide immediate feedback. This combination makes the learning experience more effective and engaging (Lestari et al., 2022).

An appropriate instructional model is required to optimize the use of digital worksheets. Inquiry-Based Learning (IBL) supports critical thinking through questioning, hypothesizing, and analyzing data (Sam, 2024). Integrating IBL with digital worksheets promotes student-centred learning aligned with the Merdeka Curriculum, which emphasizes adaptive and contextual learning (Utaminingsih et al., 2024).

Digital worksheets are a form of teaching material practically used to support learning. Digital worksheets are an innovation from printed worksheets that are converted into digital form by utilizing computer technology so that students can interact with the material provided holistically (Omonayajo et al., 2022). Digital worksheets provide students and their teachers immediate feedback on concepts and questions by displaying files in various formats, including text, images, and videos, encouraging students to be more engaged and enhancing their learning approach (Alwafi, 2023).

An appropriate instructional model must be employed to maximize further digital worksheets' impact on students' mathematical thinking. The inquiry-based learning model is suitable as it emphasizes critical and analytical thinking in constructing knowledge (Reuter, 2023). Inquiry learning encourages students to actively participate in their learning by posing questions, making observations, formulating hypotheses, interpreting data, and drawing conclusions (Shanmugavelu et al., 2020). This model aligns well with digital worksheets, as both approaches promote student-centred learning, exploration, and deeper engagement with content (Butcher, 2024).

The inquiry learning model is a series of learning activities emphasizing the critical and analytical thinking process to seek and find answers to the problems presented. Applying inquiry learning methods in the teaching and learning process provides more opportunities for students to learn a process or how to find and formulate a concept (Siller et al., 2024). Thus, students, in addition to getting material from teachers and learning media, can also have the opportunity to develop critical thinking abilities. Inquiry is a learning model that emphasizes the analytical thinking process to seek and

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find answers to a questionable problem (De Mast et al., 2023; Fry et al., 2025) and connects one discovery with another (Prayogi et al., 2024). Inquiry encourages students' mathematic process skills, such as defining problems, formulating hypotheses, and observing and interpreting results during the learning process (Wang et al., 2023), to seek and find answers to the problems they question (Shanmugavelu et al., 2020). Questions that clarify note relationships offer opinions, interpret, and explain critical mathematical thinking as the key to Inquiry (Ben-Dor & Heyd-Metzuyanim, 2025). Thus, students, in addition to receiving material from teachers and learning media, also have the opportunity to develop critical thinking abilities (Vincent-Lancrin, 2023; Yustitia et al., 2024).

Based on these considerations, one effective effort teachers can undertake is implementing an inquiry-based learning model, which is well-suited to support the development of students' mathematical thinking skills. Therefore, the purpose of this research is to develop inquiry-based digital worksheets on the topic of cubes and rectangular prisms for grade 8 junior high school students. These worksheets are intended to be valid and practical and enhance students' mathematical thinking abilities. In addition, this study also aims to examine the potential effects of the developed digital worksheets on improving students' mathematical thinking skills.

METHODS

This study aims to develop an instructional product in the form of inquiry-based digital worksheets to enhance the mathematical thinking abilities of eighth-grade students, specifically in understanding the concepts of cubes and rectangular prisms (Adams et al., 2023; Lowrie & Logan, 2023). These digital worksheets are designed to align with the principles of the Merdeka Curriculum, which emphasizes adaptive, contextual, and student-centered learning (Kusmanto et al., 2024). By integrating inquiry-based learning into digital media, the product seeks to provide meaningful learning experiences that stimulate students' critical thinking and active engagement in problem-solving (Elmi, 2025)

This research adopts a development approach consisting of two primary phases: the preliminary stage and the prototyping stage (Malalina et al., 2023; Tessmer, 2013). The study was conducted at SMP Negeri 3 Batanghari and involved students from the eighth grade with varying levels of mathematical ability. Two classes were randomly selected as the research subjects. One class was assigned for one-to-one and small group trials, while the other was prepared for the field testing phase. Experts first validated the developed digital worksheets to ensure content accuracy and instructional feasibility. Subsequently, the worksheets were tested on eight students in a limited trial to assess their practicality and initial effectiveness. Feedback from these trials was used to revise and refine the product prior to broader implementation.

Preliminary stage

The preliminary stage focuses on the initial design of the product, while the prototyping stage involves several steps to evaluate, revise, and validate the product systematically. The preliminary stage includes activities such as needs analysis, literature review, and initial product design. The outcome of

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this stage is a conceptual framework and a draft version of the inquiry-based digital worksheets.

The prototyping stage

The prototyping stage is carried out through five sub-stages as follows:

1. Self-Evaluation Stage

At this stage, the researcher evaluates and reviews the initial draft of the digital worksheets to ensure alignment with content, construct, and language standards. This internal evaluation helps to identify potential issues before external validation. The result of this stage is referred to as Prototype 1.

2. Expert Review Stage

The revised worksheets are then submitted for expert validation. In this stage, subject matter experts and media/design experts review the digital worksheets to determine their appropriateness in terms of content accuracy, construct validity, and language clarity. Feedback from experts is collected in the form of suggestions and comments, which serve as the basis for subsequent revisions.

3. One-to-One Stage

In this phase, the digital worksheets are tested by three students with heterogeneous abilities, representing various cognitive levels and learning styles. This stage aims to evaluate the empirical validity of the product. Students are asked to complete the worksheets, after which they participate in interviews to identify any difficulties, misunderstandings, or weaknesses in the product. The feedback is used to further refine the worksheets.

4. Small Group Stage

The refined version of the worksheets is then tested on a small group of six students, selected to represent a diverse range of abilities and learning preferences. This stage is intended to assess the practicality of the digital worksheets in a more interactive setting. Observations are made on student engagement, ease of use, and the ability of the worksheets to support the learning objectives.

5. Field-Test Stage

The final trial is conducted with the actual research participants, namely the students of Class VIII-5 at SMP Negeri 3 Batanghari. During this stage, students use the digital worksheets in real classroom conditions as part of the learning process. At the end of the instructional activities, students are given a post-test to evaluate the effectiveness of the worksheets, particularly in improving their mathematical thinking ability.

Data collection techniques in this study were validation sheets, tests, questionnaires, observations, interviews, and documentation (Creswell & Creswell, 2023). The validation sheet was used as a reference in the expert review stage to assess the content validity of the inquiry-based digital worksheet (Plomp & Nieveen, 2013). Mathematical thinking ability tests were used to measure students' mathematical thinking capabilities (Ukobizaba et al., 2021). The tests were administered at the end of the field test activity. The questionnaires used in this study include expert validation questionnaires and student practicality questionnaires. Both questionnaires use a Likert scale format (Tanujaya et al., 2022). The practicality questionnaire was administered to students during the small group stage. The results of the expert validation questionnaire serve as a reference to determine the validity of the inquiry-based digital worksheet, while the

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results of the student practicality questionnaire are used to assess the practicality of the inquiry-based digital worksheet. Observation was conducted to monitor student behavior during the learning process. Interviews were used to gain deeper insights into students' thought processes when solving test questions (Monday, 2020). Documentation served as evidence of all research activities.

All data obtained were analyzed descriptively and qualitatively, starting with examining the data, reducing it, and then presenting the results in narrative form (Negou et al., 2023). Data from the validation sheet was analyzed by taking into account the validator's suggestions and comments. Test result data is presented in narrative form concerning the following indicators.

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Table 1. Indicators of mathematical thinking

No	Indicators
1	Identifying problems
2	Trying out some possible cases
3	Reflecting on the idea
4	Making a conjecture
5	Presenting the reason for the emergence of the conjecture
6	Review the results obtained.

After obtaining the results, to see the level of validity, refer to the criteria in Table 2. The minimum criterion for validity is achieving a "Valid" level (61%-80%) or higher to ensure the inquiry-based digital worksheet meets the required standards for content, media, and language aspects.

Table 2. Percentage criteria for validity

Level of Validity	Validity Criteria
$85 < Na \leq 100$	Very valid, can be used without revision
$70 < Na \leq 85$	Fairly Valid, can be used with minor revisions

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Level of Validity	Validity Criteria
$50 < Na \leq 70$	Less Valid, recommended not to be used as it requires major revisions
$20 \leq Na \leq 50$	Invalid, not to be used

To determine the category of practicality of the digital worksheets developed, refer to the following Table 3. The minimum criterion for practicality is achieving a "Practical" level (61%-80%) or higher to ensure the digital worksheet can be effectively implemented in learning activities.

Table 3. Practicality criteria

Level of Achievement (%)	Description
$84 < Na \leq 100$	Very Practical
$68 < Na \leq 84$	Practice
$52 < Na \leq 68$	Practical enough
$36 < Na \leq 52$	Not Practical
$20 < Na \leq 36$	Very Not Practical

Students can obtain a minimum score of 0 and a maximum score of 100 by working on test questions. Then, the final scores will be grouped based on the following Table 4. The minimum criterion for mathematical thinking ability is achieving a "Sufficient" level (score $\geq$ 60) to indicate that students have adequately developed their mathematical thinking skills through the inquiry-based digital worksheet.

Table 4. Categories Of mathematical thinking ability

Score	Criteria
$90 < n \leq 100$	Very good
$80 < n \leq 89$	Good
$70 < n \leq 79$	Sufficient
$n \leq 70$	Less

This data analysis was carried out descriptively, meaning that the researcher provided a detailed description of the interview results. The results of this interview were obtained at the field test stage to see the potential effects of the inquiry-based digital worksheets that had been developed.

RESULTS AND DISCUSSION

This research consists of two stages, preliminary and prototyping.

1. Preliminary

a. Concept

A cube consists of six sides, all of which are squares with equal side lengths. Understanding the square as the basic component of a cube helps students understand that the surface area of a cube is the result of calculating the area of six squares. A block consists of six sides, where each pair of opposite sides is a rectangle. However, to find the surface area, students need to understand how to calculate the area of each rectangle (which can be seen as two pairs of rectangles and one pair of squares). Then, in the inquiry process, students can measure the sides of the square and calculate its area.

So that students can connect the concept to the cubes and blocks by arranging several squares to form a cube and rectangles for blocks.

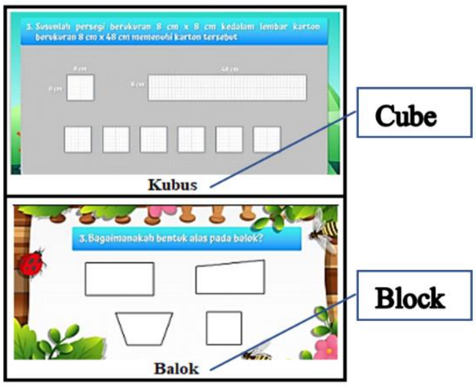

Figure 1. Square concept in digital worksheets arrangement

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Based on Figure 1, the concept used is the concept of a square in the arrangement of inquiry-based digital worksheets. This stage is carried out by researchers before designing the design of digital worksheets.

b. Design Digital Worksheets

In making the design of digital worksheets, researchers used supporting applications such as Microsoft PowerPoint, Live Worksheets, and WordPress. Microsoft PowerPoint was used to visually design the arrangement of the steps to find the surface area formula. Then, using digital live worksheets to turn the material into interactive worksheets that can be assessed automatically, thus reducing the teacher's workload in assessment and providing fast and accurate results, and finally using WordPress for web creation, which is used when conducting trials at school.

In designing, researchers pay attention to several aspects, namely the type of font, image, layout, and color. Then the design is given to the validator for validation.

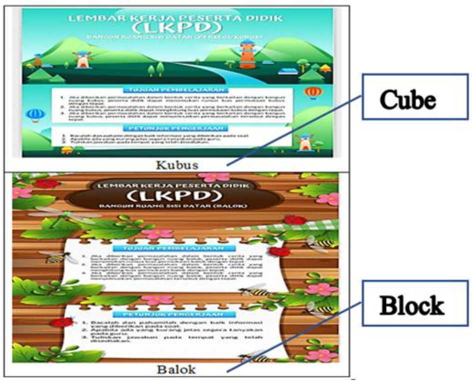

Figure 2. Result of design

2. Prototyping

a. Self-evaluation

At this stage, researchers independently evaluated the product developed by researchers or called the initial prototype. In conducting the evaluation, the researcher asked for suggestions and assessments from peers and supervisors. The evaluation carried out by researchers independently has previously been confirmed by the thesis supervisor.

Based on the revisions that have been given by the thesis supervisor regarding the implementation of the self-evaluation stage, it can be concluded that the inquiry-based digital worksheet product is good and appropriate. The results at this stage were in the form of a prototype and continued to the expert review stage.

b. Expert review

At this stage, researchers evaluate digital worksheet products that have been designed and evaluated by researchers themselves so that they become prototype 1, then validated by validators or experts. The results of the validation at the expert review stage were used as a basis for making improvements and refining the digital worksheets developed. The following are the results of the assessment of the validation questionnaire sheet by the three experts.

Based on the results of validation conducted by three experts through the Expert Review stage, inquiry-based digital worksheets can be categorized as very valid, with an average score of 96, and can be used without revision.

Table 5. Results of the expert validation questionnaire assessment

Validator	Score	Category
Dr. BM	100	Very valid
HL, M.Pd.	88	Very valid
EE, S. Pd.	100	Very valid
Average	**96**	**Very valid**

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c. One-to-one

At this stage, the inquiry-based digital worksheets that have been improved and declared valid at the expert review stage are then tested on 3 grade 8 students at SMP Negeri 3 Batang Hari. At this one stage, researchers gave questionnaires to 3 students, namely VAP, ZA, and YNF.

Figure 3. Documentation One-to-One

In this one-to-one stage, students are asked to observe the digital worksheets carefully and then give suggestions or comments on the worksheets that have been observed. Suggestions or comments given by students can be used by researchers as a consideration for improving digital worksheets. Based on the results of student trials of the digital worksheets given, an average score of 94.5% was obtained with a very valid category.

After the digital worksheets have been validated by experts at the expert review stage and tested at the one-to-one stage, they will be used to revise or improve prototype I into prototype II. Digital worksheets that have become prototype II will be tested at the small group stage, which aims to determine the level of product practicality.

d. Small Group

At the small group stage, this is done by dividing students into small groups of 5-6 students. at this stage, students are divided into 2 groups, each group consisting of 6 students.

Figure 4. Documentation Small Group

Students were asked to observe the digital worksheets together and provide suggestions and comments from their observations in the questionnaire provided.

Table 6. Recapitulation of Practicality Questionnaire Results

Respondents	Score	Practicality Criteria
R1	80	Practice
R2	83	Practice
R3	78	Practice
R4	83	Practice
R5	80	Practice
R6	73	Practice
R7	78	Practice
R8	80	Practice
R9	80	Practice
R10	80	Practice
R11	80	Practice
R12	75	Practice
Average	**79**	**Practice**

Based on the average score given, it is obtained that the inquiry-based digital worksheets to improve the mathematical abilities of grade 8 SMP students that have been developed can be said to be practical with an average score of 79.

e. Field test

This stage is the final stage of pro-totyping. This stage aims to determine the potential effects of inquiry-based digital worksheets to improve the

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mathematical thinking ability of grade 8 SMP students. Mathematical thinking ability can be seen from the test questions.

1) First Meeting

The first meeting was held on May 15, 2024, in class hours from 6 to 7. The researcher acted as a teacher in the learning process. Before starting learning, the researcher appealed to students to sit according to their respective groups so as not to take too much time when forming groups.

Next, the researcher distributed a link to one of the group representative students to access the digital worksheets. Then, the researcher gave directions and instructions for working on digital worksheets to students. The researcher gave time to all groups to work on digital worksheets by discussing with their respective group members.

Figure 5. Group discussion activity

After completing the digital worksheets, the researcher invited one group representative to present the results of the discussion on the digital worksheets that had been done.

At the end of the lesson, the researcher evaluated the results of student discussions and directed students to make conclusions about the learning that had been done, and the researcher equalized students' understanding by emphasizing the concepts learned.

2) Second Meeting

After conducting the learning process at the first meeting using digital worksheets, researchers gave tests to students. The test was conducted with the aim of seeing the potential effect of the inquiry-based digital worksheet that had been developed. The test was conducted on May 20, 2024, in the 5th to 6th lesson hours, face-to-face. The test questions consisted of 5 questions made in accordance with the abilities to be achieved. The processing time of the test questions is 70 minutes.

Figure 6. Field test activity

Data analysis to see students' mathematical thinking ability is seen from the results of student work in solving test questions. The following test questions are used to measure students' mathematical thinking ability.

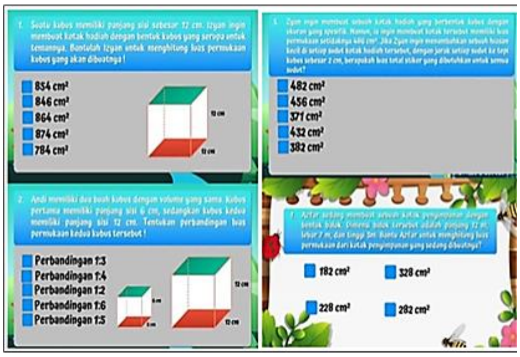

Figure 7. Test questions

The results of the students' answers were analyzed to see the potential effect of using inquiry-based digital worksheets based on students' mathematical thinking abilities.

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Table 7. Results of mathematical thinking ability on test questions

Score	Criteria	Frequency	Percentage
$90 < n \leq 100$	Very Good	23	79,3%
$80 < n \leq 89$	Good	3	10,3%
$70 < n \leq 79$	Sufficient	1	3,4%
$n \leq 70$	Less	2	6,9%
Total		**29**	**100%**

Based on Table 7, the results of students' mathematical thinking ability were obtained in as many as 23 people with a percentage of 79.3% categorized as very good, then as many as 3 people with a percentage of 10.3% categorized as good, as many as 1 person with a percentage of 3.4% categorized as sufficient, and as many as 2 people with a percentage of 6.9% categorized as less.

From the results of the above calculations, 5 students were selected to be interviewed based on mathematical thinking indicators. The interview results obtained stated that the indicator that appeared most often was the specialization indicator. The indicator that appears least often is the conjecturing indicator.

Valid and practical inquiry-based worksheet for mathematical thinking

The development of inquiry-based digital worksheets resulted in a valid and practical product for improving grade 8 students' mathematical thinking ability. The digital worksheets achieved 96% validity from expert validation and 79% practicality from student responses. The effectiveness test showed significant improvement in students' mathematical thinking ability. Post-test results indicated that 85% of students achieved "Good" to "Very Good" scores (≥ 61), compared to 45% in the pre-test. The average score increased from 52.3 to 78.6, representing a 26.3-point improvement. These findings align with previous research on inquiry-based learning effectiveness (Lu et al., 2025; Sam, 2024) and the benefits of digital worksheets (Lestari et al., 2022; Susanti et al., 2025). This study contributes by integrating inquiry learning with digital worksheets for cube and beam topics, addressing the instructional needs of 21st-century classrooms (Alam & Mohanty, 2023). The results demonstrate that inquiry-based digital worksheets effectively enhance students' mathematical thinking skills and provide educators with a practical tool for 21st-century learning objectives.

Potential effects of the inquiry-based worksheet on students' mathematical thinking

The development and implementation of inquiry-based digital worksheets in this study demonstrated significant potential to enhance students' mathematical thinking skills. During the field test with Grade VIII-5 students at SMP Negeri 3 Batanghari, the digital worksheets not only facilitated student engagement but also encouraged active participation through discussion and questioning. This behaviour indicates a strong relationship between the inquiry-based digital learning design and increased student motivation and curiosity (Ben-Dor & Heyd-Metzuyanim, 2025; Vincent-Lancrin, 2023). The format enabled students to explore mathematical problems more

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deeply, suggesting that inquiry as a learning model, when integrated with digital media, can create an adequate space for fostering mathematical reasoning. The main finding of this study is the improvement in students' ability to demonstrate indicators of mathematical thinking, particularly the specialized indicator, which appeared most frequently in the students' test responses. Conversely, the conjecturing indicator was least observed, suggesting that while students were able to identify specific patterns and examples, they faced more difficulty in generalizing or predicting based on patterns. A total of 23 students completed the test, further confirming the worksheets' potential to improve learning outcomes. These outcomes were supported by the structure of the worksheets, which provided step-by-step inquiry prompts that scaffolded students' thinking processes. Several factors contributed to the effectiveness of the digital worksheets. The interactive and visual features of the digital format allowed students to process complex information more easily (Alam & Mohanty, 2023; Butcher, 2024), while the inquiry-based structure gave them autonomy and space for exploration. In addition, the comfortable and communicative atmosphere between students and the facilitator reduced anxiety and encouraged openness during the learning process, further supporting their engagement. The relevance of the material to students' developmental stages also played a crucial role in maintaining their interest and participation. One of the significant strengths of this study is its rigorous development process, which involved expert validation, iterative revisions, and practical trials to ensure both content accuracy and usability. The use of technology aligned well with current educational demands and provided a relevant and modern learning experience.

However, the study also had limitations, particularly the small sample size and the limited emergence of higher-order thinking indicators like conjecturing. These limitations suggest the need for further refinement in worksheet design to stimulate deeper levels of abstraction and reasoning (Fry et al., 2025). The findings of this study demonstrate alignment with previous research conducted by Goos and Kaya (2020), Reuter (2023), and Siller et al. (2024), who consistently emphasized the positive impact of inquiry-based learning and digital worksheets on students' critical thinking skills and learning engagement. These results are also supported by findings from Elmi (2025), who highlighted that collaborative platforms and inquiry scaffolds can effectively foster students' reasoning and exploration in higher education. Additionally, Ay and Dağhan (2023) emphasized that integrating inquiry models in digital environments enhances critical and creative thinking, particularly when supported by reflective and student-centered tasks. However, this research extends beyond prior studies by specifically integrating inquiry learning principles into digital worksheets designed for three-dimensional spatial geometry topics such as cubes and beams, thereby offering a novel methodological approach and contributing new insights to the existing body of literature. In terms of implications, this study provides a practical contribution to the design of technology-supported learning materials that are aligned with inquiry-based pedagogy and 21st-century skill demands. For educators, it offers a

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concrete tool that encourages active, reflective, and student-centered learning. For researchers and curriculum developers, the findings underscore the importance of combining inquiry strategies with digital formats to support deeper learning processes. Thus, the study contributes both to practice and theory in the field of mathematics education in the digital era.

CONCLUSIONS AND SUGGESTIONS

The results of this study indicate that the inquiry-based digital worksheets developed for Grade 8 cube and beam material are both valid (average score of 96) and practical (average score of 79%), making them suitable for classroom use. They also show potential to enhance students' mathematical thinking abilities. This potential effect is supported by test and interview results: 79.3% of students performed at a very good level, with the specialization indicator most frequently demonstrated, while conjecturing appeared the least. This suggests students are adept at working with examples but may need further support in making generalizations. In conclusion, inquiry-based digital worksheets are effective tools for developing mathematical thinking, particularly when presented in a structured and engaging format.

For future research, it is recommended to explore the use of these worksheets with students of varying academic abilities or in different educational contexts to assess broader applicability. Additionally, further refinement of worksheet tasks could help stimulate higher-order thinking indicators such as conjecturing, which were less commonly demonstrated in this study. This research may serve as a reference for educators and developers in designing technology-based instructional materials that integrate inquiry learning for mathematics education.

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