

Digital geometry worksheets with an agro-tourism context: A catalyst for rational thinking in generation alpha

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Abstract

Implementing the Merdeka curriculum and strengthening character are necessary to foster rationalism in the Alpha generation, which is highly dependent on technology. One way is to develop geometry teaching materials based on the local agrotourism context, which has been proven effective in stimulating students' problem-solving skills. This study proposes to develop digital teaching materials on geometry content, grounded in the agritourism context, that are valid, practical, and effective in supporting students' rationalism in the Alpha generation in junior high school. The research method used is a design research type development study, consisting of 3 stages: the preparation phase, the prototyping phase, and the evaluation phase. The research subjects consisted of 80 seventh-grade students from SMPN 13 Palembang, representing Generation Alpha learners who are familiar with digital technology and visual-based learning. The study was conducted over one academic semester and followed the three stages of design research: preparation, prototyping, and evaluation. Data were collected through work-throughs, student interviews, and tests. The results show that digital worksheets are valid, practical, and effective, supporting students' rational thinking skills. The validity aspect was demonstrated through expert evaluations indicating that the digital worksheet met pedagogical and contextual standards, including content accuracy, alignment with learning objectives, clarity of instructions, contextual relevance, and technical presentation, with only minor revisions recommended. The practicality aspect emerged from the one-to-one and small-group trials, where students were able to use the worksheet independently, navigate the task flow clearly, and show positive engagement with the digital activities. Digital worksheets also have the following characteristics: they contain questions that encourage students to provide supporting reasons for their answers, are packaged in digital form, and are easy to use. The digital worksheets developed have been effective in supporting students' rationalism values.

Keywords:

Agro-tourism, Digital worksheet, Generation alpha, Geometry, Rationalism value

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1. INTRODUCTION

Geometry is one of the math topics studied in school. A good understanding of geometry can help students understand other math topics such as algebra (Barana, 2021) and calculus (Zengin, 2022). Mastery of geometry material is important for students to form students' thinking skills (Cesaria & Herman, 2019). Thinking ability is related to the cognitive aspects of students. In addition to cognitive elements, other aspects need attention, namely affective aspects. One related to this aspect is the value (Beltrán-Pellicer & Godino, 2020; Grootenboer & Marshman, 2016). In learning geometry, these two aspects are interrelated (Aisyah et al., 2023). Recent policies in Indonesian education emphasize literacy, numeracy, and character education (Mendikbudristek, 2024). This shows that character education gets special attention so that Indonesian students have noble character values in addition to having a good intellect. One of the values of mathematics is the rationalism value. Mathematics is closely related to rational values because it is based on reason and knowledge (Parulian Sijabat et al., 2022). The value of rationalism is a value related to ideas that depend on reasoning, arguments, explanations, and logic (Davis et al., 2019). The value of rationalism in question is drawing conclusions or providing reasons for the steps in solving the problems that have been made. Zhang (2019) stated that the results of this rationalism value develop students' skills in terms of reasoning, expressing and defending their opinions, interpreting data obtained from experience and efforts to make predictions. Rationalism is the main value in mathematics because it uses logical thinking and hypotheses which are part of the discipline of mathematics. so, it is hoped that later when teachers integrate this rationalism value into learning, it can train students to think by involving components in the rationalism value itself such as reason, logic, explanation, and argument (Corey & Ninomiya, 2019).

Rationalism in mathematics education emphasizes reasoning, justification, and the use of logical inference as foundations for constructing mathematical understanding (Cornelius & Ernest, 1991). Within the domain of geometry, such rational engagement is inherently activated through spatial visualization, abstraction, and deductive reasoning (Duval, 1998; Fischbein, 1993). Geometric tasks require learners to interpret relationships, formulate arguments, and draw logical conclusions from visual and contextual information—processes that mirror the cognitive mechanisms of rational thinking. In this sense, rationalism can be viewed both as a process, in which learners move from perceptual reasoning toward formal and logical inference, and as an outcome, reflected in their ability to justify solutions and make coherent judgments (Gravemeijer, 1999).

While rationalism serves as a fundamental epistemological value in mathematics, its educational manifestation can be observed in students' ability to reason logically, justify their ideas, and make evidence-based decisions during problem-solving activities (Bishop, 1991; Cornelius & Ernest, 1991). In geometry learning, these rational capacities emerge when students transition from intuitive visual interpretations to analytical reasoning supported by formal justification (Duval, 1998; Fischbein, 1993). However, numerous studies have shown that students often struggle to engage in such reasoning processes (Aisyah, 2016; Aisyah et al., 2023; Angraini et al., 2023; Baginda, 2018; Mandala et al., 2025; Santana-Ramírez et al., 2025; Siregar et al., 2025; Tak et al., 2025). Their explanations tend to remain at a perceptual level, lacking logical coherence and sufficient justification (Hoyles & Küchemann, 2002;

Nugroho et al., 2018; Tatsis & Koleza, 2008). This gap indicates that, although rational thinking is a valued goal in mathematics education, students' current reasoning abilities remain relatively low and require intentional pedagogical support (Aisyah et al., 2023; Darmawijoyo et al., 2025; Safura et al., 2018). Therefore, exploring innovative strategies—such as integrating contextualized, technology-enhanced learning materials—becomes essential to foster rationalism in geometry learning.

The learning process in the classroom has a role in shaping students' understanding of geometry material (Meryansumayeka et al., 2022). Teaching materials, as one of the important components in classroom learning, need to be designed and developed according to the learning objectives to be achieved (Rufii, 2015). Previous research states that the internalization of values can be done by teachers by utilizing technology-assisted teaching materials (Aisyah et al., 2019). Value in mathematics learning explains three types of value, namely general education values related to character values, mathematics education values related to didactic values, and mathematics values related to mathematical reasoning (Aisyah, 2016). Along with technological developments, mathematics teaching materials are packaged in digital form. The use of digital-based teaching materials can support the student learning process and student skills in solving mathematical problems (Hidayat & Aripin, 2023; Hidayat et al., 2025; Kurniansyah et al., 2022; Yerizon et al., 2025; Zwart et al., 2020). In terms of teaching material content, previous research states that the use of context can stimulate students to think about solving math problems (van Galen & van Eerde, 2019). Students work based on the understanding they have through the context provided (Zulkardi et al., 2020). Some areas in South Sumatra promote agro-tourism where visitors can enjoy the scenery of the agricultural environment, plantations, and livestock while traveling. Agritourism is a tourism activity related to the agricultural sector (Kader & Abd. Radjak, 2020). This agritourism context has the potential that be utilized for the needs of learning geometry because it contains elements of geometry such as flat shapes, and the concept of area and perimeter (Mestanza-Ramón et al., 2023). The majority of previous research examines mathematics learning by involving students in Generation Z, namely students born in 1995-2000. Meanwhile, students born in 2010-2025 are known as the Alpha generation (Ziatdinov & Cilliers, 2021). Beyond the generational focus, the uniqueness of this study lies in the pedagogical integration of digital, contextual, and value-oriented learning to cultivate students' rational thinking in mathematics. Digital worksheets designed within agro-tourism contexts do not merely serve as interactive media but act as cognitive bridges connecting students' real-world experiences with abstract geometric reasoning. Such contextual digital environments encourage learners to interpret, justify, and make sense of mathematical relationships embedded in authentic settings—key processes that underpin rationalism in mathematics education (Bishop, 1991; Cornelius & Ernest, 1991). By situating geometry within meaningful agro-tourism experiences, students are prompted to reason beyond memorization, to question assumptions, and to develop evidence-based conclusions. This conceptual and pedagogical linkage highlights how digital agro-tourism materials can function as catalysts for nurturing rational thinking—thus contributing a distinctive perspective to current research on technology-enhanced mathematics learning for Generation Alpha. Research linking the use of agro-tourism context for geometry learning needs of students in

the Alpha generation is still not much done. Thus, this study was conducted to develop digital teaching materials on the topic of geometry using the context of agritourism that is valid, practical, and effective to support the value of students in the Alpha generation in junior high school.

2. METHOD

This study used the design research method of development studies. The design research approach was chosen because it aligns closely with the study's objective to develop and iteratively refine digital teaching materials that embody contextual and value-oriented learning principles. Design research enables systematic exploration of how theoretical ideas—in this case, rationalism as a mathematical value—can be translated into practical learning designs and tested in authentic educational settings (Bakker, 2018; Gravemeijer & Cobb, 2006). Through its cyclic nature of analysis, design, and evaluation, this approach allows researchers to respond adaptively to emerging insights from classroom implementation, ensuring both the theoretical robustness and practical relevance of the developed materials. Specifically, the method supports the validation of digital agro-tourism worksheets not only in terms of usability and content accuracy but also in their potential to stimulate students' rational thinking processes during geometry learning.

2.1. Research Subject

The participants of this study were 80 seventh-grade students (aged 13–14 years) from SMPN 13 Palembang, representing early adolescents who are part of Generation Alpha, a cohort characterized by their high familiarity with digital technology and preference for interactive, visually engaging learning environments. The selection of this group was purposeful, as the developed digital worksheets were designed to align with the cognitive, social, and technological profiles of this generation—students who tend to learn effectively through digital media, gamified features, and contextualized problem-solving tasks.

2.2. Research Stages

The stages in this research include: preliminary, prototyping, and assessment (evaluation). Each stage involved systematic activities aimed at developing, refining, and validating the digital worksheets.

Preliminary Stage

At this stage, researchers reviewed the research literature related to the development of digital teaching materials using the context of agritourism on the topic of geometry. Researchers also reviewed research related to value. Furthermore, researchers also designed research instruments in the form of validation sheets, interview guidelines, and instrument tests. Relevant literature and curriculum documents were analyzed to identify learning needs and contextual opportunities for integrating agro-tourism into geometry learning.

Prototyping Stage

This stage included iterative development through self-evaluation, expert review, and one-to-one trials, small group (Akker et al., 2013; Bakker, 2018), which led to successive revisions of the product.

The development process of the digital worksheets followed an iterative design cycle, with revisions made at each prototype stage based on feedback from different evaluation activities. Prototype 1 was created after the initial design and underwent a self-evaluation and expert review. During this stage, experts pointed out that some visual representations of agro-tourism settings were too complex for elementary students, and several instruction sentences were linguistically demanding. In response, the visuals were simplified by reducing unnecessary background details, the text instructions were rewritten using age-appropriate language, and guiding prompts were added to scaffold students' reasoning.

Prototype 2 was developed after incorporating the expert feedback and then tested in a one-to-one trial with three students. The results indicated that some students experienced confusion in sequencing tasks and interpreting diagrams. Based on these findings, the layout of activities was reorganized to follow a more logical problem-solving flow, transition cues were inserted between tasks, and example problems were added to clarify expectations.

Subsequently, Prototype 3 emerged from the small-group trial involving six students. Observations showed that while engagement increased, some students still struggled to connect geometric reasoning with contextual situations. Therefore, reflective questions were embedded at the end of each task to prompt justification and evaluation of reasoning—key indicators of rational thinking. Additionally, minor technical refinements were made to enhance navigation and interactivity in the digital format.

These successive revisions demonstrate the iterative nature of design research, where each prototype was systematically improved based on empirical feedback and expert validation to ensure that the final product was pedagogically sound, contextually authentic, and effective in fostering rational thinking.

Assessment Stage

The assessment stage focused on examining the effectiveness of the final prototype in fostering students' rational thinking. Effectiveness was determined not through pre-post quantitative comparison but through qualitative observation of how students demonstrated indicators of rational thinking while engaging with the digital worksheets. These indicators included (1) providing logical justifications for geometric relationships, (2) constructing coherent arguments supported by contextual evidence, and (3) reflecting on the validity of their reasoning. The emergence of these behaviors in students' written responses and discussions was interpreted as evidence of the digital worksheet's effectiveness. Thus, the evaluation emphasized the quality of reasoning processes rather than numerical learning gains, aligning with the study's focus on the development of rational thinking as a mathematical value.

The development of digital teaching materials is aimed at supporting students' rationalism values. The indicators of students' rationalism values in the study were adapted from Davis et al. (2019).

Table 1. Indicator of rationalism value

No.	Indicator	Description
1.	Students investigate and represent images of appropriate mathematical objects along with information to simplify the problem.	Students represent problems and write down appropriate information based on their investigations.
2.	Students provide reasons/arguments for the answers they give.	Provide reasons for answers/solution steps
3.	Students draw conclusions from mathematical solutions	Draw conclusions regarding the solution steps

The indicators used to assess the development of students' rationalism during the learning process are outlined in [Table 1](#). These indicators serve as a reference for evaluating students' abilities to think logically, justify their answers, and draw valid conclusions based on the mathematical problems they encounter. As shown in [Table 1](#), the first indicator emphasizes students' skills in investigating and representing mathematical objects by gathering relevant information to simplify problem-solving. The second indicator focuses on students' ability to provide logical reasons or arguments for the answers they produce. Meanwhile, the third indicator highlights students' competence in concluding the results of their mathematical thinking. These indicators collectively guide the assessment of rationalism throughout the learning activities.

2.3. Data Analysis

The data in this study were analyzed descriptively and qualitatively to capture the depth and contextual nuances of the design research process. Since the study focused on the validity, practicality, and effectiveness of digital worksheets in fostering students' rational thinking, the analysis emphasized patterns of responses and evidence of rational reasoning during implementation rather than numerical testing outcomes

For the qualitative analysis, data from expert validation comments, interview transcripts, and student responses in the digital worksheets were examined using thematic analysis. This process involved three stages: Data reduction, where relevant excerpts were identified and categorized according to the research focus (e.g., clarity of content, usability, rational thinking indicators); Data display, where themes and subthemes were organized into tables or matrices to highlight recurring patterns or issues emerging from expert and student feedback; an Conclusion drawing and verification, where themes were interpreted to generate insights about product quality, user experience, and learning outcomes.

In analyzing students' work, a content analysis approach was applied to identify the emergence of rational thinking indicators such as logical reasoning, use of evidence, and justification of mathematical steps. These indicators were compared across different prototypes to observe improvements resulting from the iterative design process.

3. RESULTS AND DISCUSSION

3.1. Results

In the preliminary stage, researchers conducted a literature study related to the characteristics of the Alpha generation and the value of rationalism. Researchers made observations in an agro-tourism place and made an initial prototype of digital worksheets of geometry content in the context of agro-tourism to support the value of rationalism of junior high school students. Digital worksheets made include 4 materials in class 7, namely: (1) the area and perimeter of the plane, (2) the volume of three-dimensional shapes (3) the surface area of polyhedral (4) the relationship between angles.

At the prototype stage, the research team held a self-evaluation of the digital worksheets that had been made, and further discussion using via Zoom meeting. So, it produces several things that need to be improved and considered from the digital worksheets that have been made. Comments on the self-evaluation stage include placing the instructions for use on the front page and developing learning objectives related to the value of rationalism.

During the self-evaluation stage, the researchers critically reviewed the initial prototype of the digital worksheets before proceeding to expert validation. This evaluation focused on three main aspects: (1) content accuracy and alignment with the intended learning objectives, (2) clarity and readability of the instructions for elementary students, and (3) technical functionality and visual design of the digital interface. The review revealed several weaknesses that required refinement. For instance, some visual representations of agro-tourism contexts were found to be too complex for students' cognitive levels, and several instruction segments contained language that was not sufficiently simple or directive. Additionally, the logical flow of the tasks did not yet fully support the progression of rational thinking indicators, such as justification and reflection. Based on these findings, revisions were made to simplify the visual layout, rephrase instructions using age-appropriate language, and reorder problem sequences to better scaffold students' reasoning. This self-assessment process ensured that the subsequent prototype submitted for expert validation was both pedagogically coherent and cognitively accessible to Generation Alpha learners.

After obtaining the digital worksheets prototype I, then the validity of the expert review was carried out. The validator stated that the digital worksheets were suitable for use with some revisions. The comments given by the validators include construct, content, and language as improvements to the digital worksheets. The suggestions from expert review and revision decisions from researchers is shown in [Table 2](#).

Table 2. Expert review comments

Validator	Comments and Suggestions
V1	<ol style="list-style-type: none"> 1. In the section on pairing the properties of flat shapes, students are given comments/revisions to get a direct understanding. 2. Learning Outcomes is paraphrased to make it more communicative. 3. Apperception is not separated from the theme, for example, mention the shapes of triangles, squares, and rectangles. 4. The school name needs to be left blank. 5. Learning Outcomes needs to be paraphrased so that it is more commutative for students, not textual as in the curriculum.

Validator	Comments and Suggestions
	<ol style="list-style-type: none"> 6. Learning video needs to be changed to be more appropriate. 7. Apperception is linked to the context of JG Garden. 8. In material 4, the apperception needs to be improved, the question about what cubes, blocks, and prisms are better changed to mention objects and their shapes in agro-tourism or draw the shapes. 9. Consistency between existing features in the previous material. 10. In material 5, it is better to use "Learning Objectives" instead of "Flow of Learning Objectives". 11. The developed digital worksheet is extraordinarily innovative and the utilization of technology is by the objectives of the study.
V2	<ol style="list-style-type: none"> 1. The video used for each material should be different so that it is not boring. 2. The value of rationalism should be made in advance of the indicators that will be measured, showing which parts of the researcher expect indicators of the emergence of the value of student rationalism. 3. At the beginning of learning before apperception, the value of rationalism can be raised by asking students to give opinions not just showing answers, for example on digital worksheets, the questions are made separate to facilitate assessment if there are students who do not answer both of them. 4. Answers on digital worksheets are not led to stages by filling in empty dots, there should be enough questions that lead students to understand the concept of the material so that it raises indicators of the value of rationalism and produces different opinions 5. 5. To conclude, it would be nice if they review based on their initial assumptions so that they understand whether their initial assumptions were correct / not. 6. Pay attention to the time allocation, if there is not enough time, if it is not enough, maybe it can be split into sub-sub-sub-sub-sub-sub-sub-sub-sub-sub-sub-sub-sub-sub-sub. 7. How about showing the object by asking students to show the part of the JG Garden that forms a spatial shape through the video presented

Table 2 indicates that validator 1 (V1) focused more on technical aspects of the digital worksheet design, such as the need for more communicative learning outcomes, consistency across materials, and the improvement of apperception to ensure stronger contextual relevance to the agro-tourism environment. V1 also highlighted that the use of technology was highly innovative and aligned with the research objectives. Meanwhile, validator 2 (V2) emphasized the need for greater media variation, such as using different videos for each topic, and the importance of clearly defining the indicators of rationalism within the materials. Overall, the feedback from both validators served as a basis for revising and refining the digital worksheet to improve its quality and effectiveness.

In line with the expert review, the researcher carried out one-to-one which was attended by 6 students in class VIII with 2 each with high, moderate, and low abilities. 3 students with high, moderate, and low abilities reviewed the digital worksheets on the area and perimeter of flat shapes and volume of spaces, and 3 others reviewed the digital worksheets on the surface area of flat-sided spaces and the relationship between angles. This trial aims to

identify obvious errors in the digital worksheets and see the obstacles faced by students in working on digital worksheets. Researchers sat together with learners who acted as reviewers of the digital worksheets. Researchers observed learners using the digital worksheets, observed the difficulties faced by learners while working on the digital worksheets and recorded and investigated all comments or questions given by learners during the digital worksheets.

Students are asked to complete all questions in the digital worksheets from the stage of understanding the problem to the conclusion. After the learners finished working on the digital worksheets, the researcher interviewed the six learners regarding the results of the work that had been obtained and the difficulties experienced by students in understanding and working on digital worksheets. The results of the answers, observations, and interviews at the one-to-one stage are used as a reference for future digital worksheet improvements so that the resulting suggestions and comments from students and the results of observations outline the many blank spots that make students confused in solving problems and the instructions in the worksheet are not very clear.

Based on the results of the expert review and one-to-one researchers revised the product. The results of product improvement resulted in digital worksheets prototype 2. After going through the expert review and one-to-one stages, the revised results of the digital worksheets are said to be valid.

In the one-to-one stage, three elementary students representing different levels of mathematical ability (high, medium, and low) interacted individually with the first prototype of the digital worksheet. The purpose was to identify usability issues and examine students' initial responses to the tasks. Data were collected through direct observation and semi-structured interviews conducted immediately after the activity. The analysis revealed three main themes of difficulty. First, students showed confusion in interpreting contextual problems related to agro-tourism activities—for example, misidentifying geometric shapes within illustrated farm layouts. Second, several instructions were perceived as too long or abstract; one student stated, “I don’t understand what to do first,” indicating a lack of procedural clarity. Third, the transition between tasks sometimes disrupted students’ reasoning flow, suggesting that the sequencing of problems needed better scaffolding. These findings were systematically categorized into content-related, linguistic, and structural issues. Based on this feedback, Prototype 2 was revised by simplifying the wording of tasks, adding guiding questions to prompt rational justification, and rearranging problem order to support a more logical reasoning progression. A concise thematic summary of these issues and corresponding revisions was developed to ensure that each identified difficulty informed concrete design improvements.

Furthermore, digital worksheets will be tested in the small group stage. At this stage, the valid digital worksheets will be tested on a group of students to evaluate the unfinished learning design. The small group stage uses learners as the main data source and focuses more on learner performance data to confirm previous revisions and produce new revisions. The purpose of this small group stage is to see the practicality of the developed product. Where the resulting product will later be implemented in small groups. The small group was held on August 28, 2024, with 12 8th-grade students who were not students in the implementation of one-to-one. 12 Students are divided into groups where 1 group consists of 3 students.

Two groups worked on digital worksheets on the area and perimeter of flat shapes and volume of spaces, and the other 2 groups reviewed digital worksheets on the surface area of flat-sided spaces and the relationship between angles. At this stage, students discuss in groups working on digital worksheets. Researchers made observations about the activities carried out by learners while answering questions. Learners work together and discuss to solve problems on digital worksheets. After the discussion activities were completed, the learners filled in the comment sheet and then the interview was conducted. Due to time constraints, the small group was only conducted in 1 hour. The student comments at the small group stage are related to the lack of time allocation to solve the problems in the worksheet.

The focus of students in small groups is fixated on time due to school conditions because students have activities, but there are notes from researchers in group discussions that when answering apperception students are confused about determining objects around and in agritourism images that match the shape with mathematical objects so the researcher decided that during learning students were given further explanation of agritourism illustrations and added to the digital worksheets that the objects mentioned could also use objects around them.

Area Of Rectangle

Based on the image above, how many unit squares are there in a rectangle? Determine its length and width. Then formulate how to determine its area!

Given:

Number of unit squares = 18 Unit squares

Length of Rectangle = 6 Unit Squares

Width of Rectangle = 3 Unit Squares

Rectangle Area Formula:

Area of Rectangle ABCD = Length of rectangle ABCD x Width of rectangle ABCD

Area of Rectangle ABCD = 6 units x 3 units Area of Rectangle ABCD = 18 units

If L is the area of a rectangle with length = p units and width = l units, then in general the area of the rectangle is...

$L = p \times l$

Activity 1

Let's investigate how to determine the Area and Perimeter of a Rectangle (Rationalism)



Based on the picture you have observed, **the picture is filled with unit squares in it.**

In your opinion, can we calculate the area of a rectangle by counting the number of unit squares in it? **State the reason for your answer** (Rationalism)

Figure 1. The example of worksheet content

As shown in [Figure 1](#), the worksheet guides students to observe a contextual image related to an agro-tourism environment, followed by a grid-based representation that allows students to identify unit squares. Students are then encouraged to calculate the area by determining the number of unit squares and by applying the area formula. In addition, reflective questions are included to stimulate rational thinking, such as asking students to justify their reasoning in determining the area. This format supports both conceptual understanding and the development of rationalism skills.

A product that meets the criteria of practicality is when it is easy to use and can be used for real situations. After testing the small group stage, the results of the analysis of comments, answers, and observations of students showed that overall the questions could be easily understood by students. During the interview, the learners could explain the meaning of the picture and the problem in the discourse. Learners also understood the language used in the digital worksheets and could solve the questions even though one group experienced errors in calculations. Digital worksheets were then revised according to the evaluation results at the small group stage and thus valid and practical teaching materials were obtained. The teaching materials were then tested at the field test stage.

Digital worksheets that have been valid and practical are tested at the next stage, namely the field test. This stage is the last stage in formative evaluation according to Tessmer which aims to see the extent to which students can use the digital worksheets that have been developed. In addition, the field test stage also aims to see the potential effects on students. This stage involves learners in one class as it is carried out in the same situation where the teaching materials will be used later. Field tests were carried out in one class of one digital worksheet involving students of class VII of SMP Negeri 13 Palembang.

The validity and practicality of the digital worksheets were evaluated through expert judgment and student trials, consistent with the design research framework. Three experts in mathematics education and instructional design assessed the worksheets using a qualitative validation sheet consisting of indicators related to content accuracy, construct coherence, language clarity, contextual relevance, and technical presentation. Rather than assigning numerical scores, experts provided descriptive feedback supported by comments and suggestions for improvement. The worksheets were considered valid when all experts indicated that the content aligned with the learning objectives, the agro-tourism context was meaningfully integrated, and only minor revisions were required for refinement.

The practicality assessment was based on data obtained during the one-to-one and small-group implementation stages. Student feedback was gathered through observation notes and post-activity interviews focusing on ease of use, clarity of instructions, engagement with the tasks, and perceived relevance of the context. The product was categorized as practical when the majority of students were able to complete the activities independently, expressed positive engagement with the digital media, and reported that the agro-tourism context made the geometry tasks easier to understand. Qualitative evidence such as student quotes and observed behavioral indicators (e.g., reduced hesitation, increased verbal reasoning) were used to support this interpretation. Although the assessment relied primarily on descriptive rather than numerical data, the criteria and decision rules were explicitly defined to ensure consistency in interpretation. The combination of expert validation and user-based practicality

analysis provided a robust qualitative basis for concluding that the digital worksheets were both valid in content and practical for classroom implementation.

In the evaluation stage, the researcher asked questions related to the prerequisite material and directed students to include reasons for each answer as one indicator of the value of rationalism. In this case, almost all students in grades VII. 2, VII. 3, VII. 4, and VII. 5 did not include reasons in answering questions from the researcher, students provided arguments after the researcher provoked them repeatedly. After providing apperception, the researcher directed students to sit in groups according to the groups divided by their teachers based on diagnostic assessments by mathematics subject teachers. Then the researcher distributed digital worksheets to each group. When distributed, the obstacles faced by researchers in each class were more or less the same due to students' adaptation to the Wizer.me website and learning to use digital worksheets. Then based on students' answers, the researcher selected research subjects with purposive sampling based on teacher recommendations and student answer results. Where in this case, 3 students each with high, medium, and low abilities. Therefore, there are 12 students as research subjects. The following is a description of the results of student answers.

Table 3. The emergence of students' rationalism values indicators

Topic	Student Ability Level	Indicators of Rationalism Value		
		1	2	3
Area and Perimeter of Plane	High (AY)	√	X	√
	Moderate (SY)	√	X	√
	Low (NM)	√	X	X
Surface Area of Polyhedral	High (NA)	√	X	√
	Moderate (SH)	√	X	√
	Low (ML)	√	√	√
The volume of the dimensional Shape	High (AM)	√	√	√
	Moderate (PU)	√	X	X
	Low (SA)	√	X	X
Relationships between Angles	High (FA)	√	X	√
	Moderate (NY)	√	X	√
	Low (DE)	√	X	√

According to [Table 3](#), it can be seen that the most frequently appearing indicators and appearing in each subject are the first indicator, namely students represent real problems into mathematical objects to achieve complexity and write down the information contained in the problem, then the third indicator, namely the conclusion draws only subjects NM, PU, and SA who do not make conclusions, then for the indicator that appears least often is students providing arguments for the reasons for each step of the solution, so the researcher conducted interviews with the subjects to confirm and explore the 2nd indicator from the research subjects. The following are the students' answers.

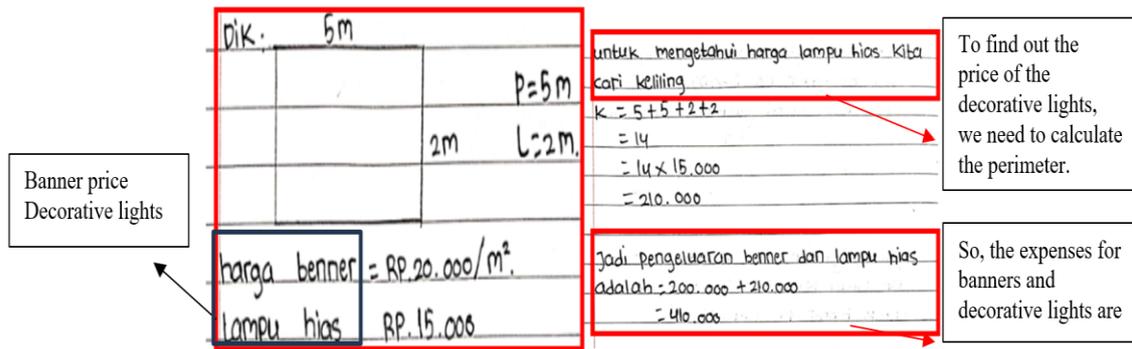


Figure 2. Student work that supports the emergence of the second indicator of rationalism values

Figure 2 shows subject (AY) can represent and simplify the problem correctly. However, AY has not written the reason. AY only wrote "To find the price of decorative lights we look for the circumference" which is true. When the researcher confirmed this through an interview, AY stated: "Around because the decorative lights are here (pointing around the rectangle). 15,000 is for 1 meter, so if for 15 meters multiplied by 15,000. That means we add the price of the banner and the decorative lights so. we get the conclusion issued by the agrotourism party of 410,000".

Subject AY can provide correct arguments because to find the price of printing a banner we must know its area and to find the price of the lights by finding the circumference because the lights are around the banner and along the circumference of the banner so it is necessary to find the circumference, then multiply by the price of the lights so the price of the lights is obtained. Then subject AY can conclude the problem by getting the money that needs to be spent by the agrotourism party by adding up the expenses for the lights and banners. So subject AY can bring up the value of rationalism to represent and simplify the problem, provide reasons for each argument, and conclude.

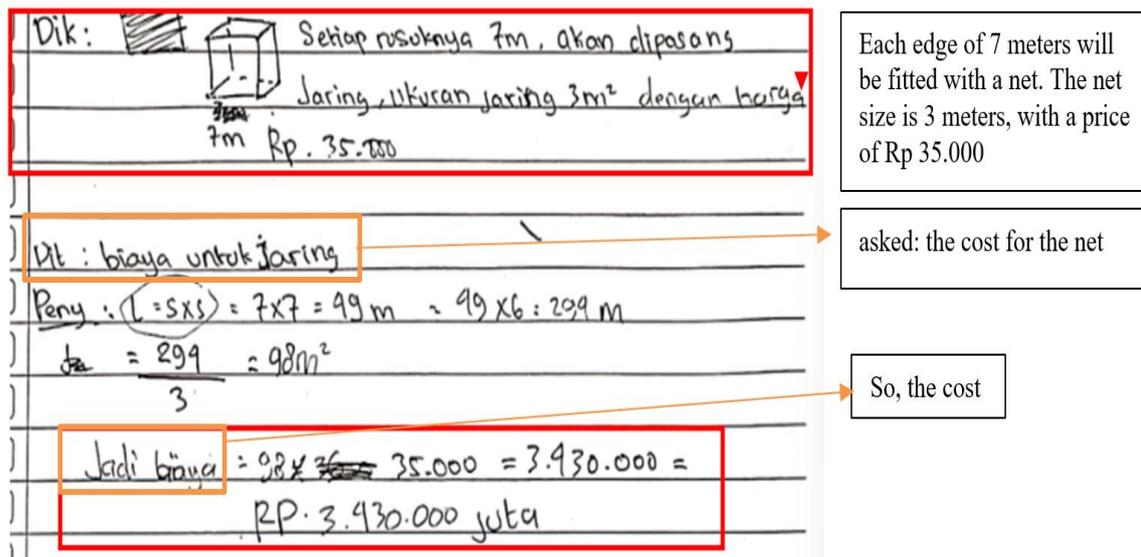


Figure 3. Student work that supports the emergence of rationalism values indicators

Likewise, with subject NA, subject NA can represent problems and simplify problems so that they know what to look for in the problem, as shown in Figure 3. However, subject NA does not provide arguments in each answer, the reasons for the operations carried out by subject NA are also unclear because subject NA looks for the area of a square multiplies it by 6 then divides it by 3, so the researcher explores NA's answer by interviewing with the following results.

- Researcher : "Then why did you multiply the area of the square by 6"
- Subject NA : "Because when the cube is opened there are 6 squares so it is multiplied by 6"
- Subject NA : "This is 6 squares and the same size so it can be multiplied by 6"
- Researcher : "Then why is it multiplied by 3"
- Subject NA : "The price is 35,000, so what has been divided by 3 we multiply by 35,000 so that we can get the net expenditure"

Subject NA can convey arguments correctly where the subject NA knows that the side of the cube is square so that the area of the square and the side of the cube is 6 so the subject multiplies by 8 the result of the square area. The results needed for the insect net are obtained, then divided by three because the price given is per 3 m² from the results, the price per 3 m² is multiplied by the needs so that the conclusion of the costs required is obtained. So that the subject NA can bring up the value of rationalism in the form of representing the problem then providing reasons in the steps of solving and drawing conclusions. Subject NA also makes the right conclusion in answering the problem.

Diketahui biaya untuk mengisi tanah (Jawaban)

$\text{volume balok} = p \times l \times t$ untuk mencari biaya
 cari biaya
 Perlu menghitung volume

$p = 9\text{ m}$
 $l = 2\text{ m}$
 $t = 0,5\text{ m}$

1 m^3 tanah harganya Rp. 90.000

$V = p \times l \times t$
 $= 9 \times 2 \times 0,5$
 $= 18 \times 0,5$
 $= 9$

Jadi volume tanah = 9
 karena harga $1\text{ m}^3 = \text{Rp. } 90.000$
 maka uang yang perlu dikeluarkan $\text{Rp. } 90.000 \times 9 = \text{Rp. } 810.000$

Jadi, uang yang perlu dikeluarkan berjumlah $\text{Rp. } 810.000$

Given: the cost for filling soil
Volume of the block =
Solution: To find the total cost, calculate the volume

The price of land is Rp 90.000

So, the volume = 9 since the price is then the amount of money needed is

therefore, the total amount of money to be spent is Rp 810.000

Figure 4. Student AM's work that contains the right conclusion

According to [Figure 4](#), subject AM can represent problems and simplify problems well, then in answering, subject AM can include arguments from the solution steps and subject AM is also able to conclude solutions to problems, this is also supported by interview activities.

Researcher : "Have you drawn this? Why is the picture like this and here there are 9, 0.2, etc. What is this?"

Subject AM : "Because the shape is a block and, in the question, the length is 9"

Researcher : "Why use volume?"

Subject AM : "Because the soil is used to fill so you have to know the volume,"

Researcher : "Then already know the volume why multiply it by 9?"

Subject AM : "Because 1 cubic meter of soil costs 90,000"

At the end of the interview session, subject AM showed a gesture in the form of Alpha gene language where the student celebrated by pointing to his cheeks and jaw line. The researcher asked subject AM about this gesture.

Researcher : "What does that mean?"

Subject AM : "Sigma mewing, sir"

Researcher : "What does sigma mewing mean?"

Subject AM : "Cool, sir"

Subject AM can state the reasons for each step of the solution correctly which is the basis for finding a solution to the problem where he investigated that the planting medium is in the form of a block from the dimensions given in the problem, namely $9 \times 2 \times 0.5$. Then find the volume of the block because what is being sought is the soil that fills the planting medium. So in this case, subject AM can represent the problem as a mathematical object and then provide reasons or arguments from the solution steps on that basis so that a conclusion is obtained.

Generation Alpha, who grew up in the age of technology and social media, tend to create and use unique terms and trends that reflect their digital lifestyle. Terms like "sigma" and "mewing" have become part of the slang used to express their identity in a way that is considered "cool" or trendy.

Question: What is the angle of elevation between the CCTV line of sight and the horizontal surface?

Ditanya: Sudut berpelurus antara garis Pandang CCTV dengan permukaan horizontal?

Jawaban: Mencari besar sudut dengan sudut berpelurus.
misalkan di beri nama
 $\angle YWX + \angle XWV = 180^\circ$
 $60^\circ + \angle XWV = 180^\circ$
 $\angle XWV = 120^\circ$

kesimpulan: jadi sudut pelurus antara garis Pandang CCTV dengan permukaan horizontal sebesar 120° .

Answer: Finding the magnitude of an angle with a straight angle. Let's denote it as:

Conclusion: the angle between the bottom line of the CCTV and the horizontal surface is 120 degrees.

Figure 5. Student FA made a representation of the problem

Figure 5 shows that subject FA was able to represent problems and simplify problems related to correct angles, but subject FA did not provide arguments or reasons in the solution steps so the researcher interviewed subject FA. Where the results of the interview are as follows.

Researcher : "Then how do you solve the problem"

Subject FA : "The correct angles total 180 degrees so just make an equation, from the equation, the result of the other angle is 180 minus 60 degrees"

Researcher : "So what is the conclusion?"

Subject FA : "So the straight angle between the CCTV line of sight and the horizontal surface is 120 degrees"

Subject FA was able to provide arguments correctly where the subject FA said that in the question given information that CCTV monitors the parking lot with a straight angle, so the correct image is a straight angle and the large straight angle is 180 degrees so that it forms an equation, so it is found that the large angle between the horizontal CCTV line of sight is 120 degrees so that the subject FA was able to bring up the value of rationalism to represent problems and provide reasons/arguments in solving problems and providing conclusions to problems.

Based on the answers and results of student answer data, the indicators that most often appear in each subject are the first indicator, namely, students represent real problems into mathematical objects to simplify problems and write down the information contained in the question, then the third indicator is concluding only subjects NM, PU, and SA did not make conclusions, then for the indicator that appears least often are students provide arguments for the reasons for each step of the solution, so the researcher conducted interviews with the

subjects to confirm and explore the 2nd indicator of the research subjects. The results of the interview showed that high-ability students were able to provide appropriate reasons for solving problems, medium-ability students were able to provide reasons but the reasons given were less relevant to the concepts taught, and low-ability students were partly unable to provide reasons for each step of the reasoning and some needed further questions so that students were able to come up with reasons in the solution steps. It was found that some students were still fixated on the formulas they had memorized in the surface area material of geometric shapes. However, when interviewed, students were able to connect concepts with existing problems because of the researcher's trigger questions. So in this case, digital worksheets for geometry content in the context of agrotourism can bring up students' rationalism values, with the suggestion that students should be helped to adapt to technology in the form of digital worksheets.

3.2. Discussion

The findings of this study align closely with the stated research objective—to develop and validate digital teaching materials that foster rational thinking among Generation Alpha students through an agro-tourism context. The data revealed that students who engaged with the digital worksheets demonstrated increased instances of logical reasoning, evidence-based justification, and reflective evaluation—key indicators of rational thinking. These results suggest that the integration of contextualized digital materials can act as a catalyst for cultivating rationalism as both a cognitive process and a learning outcome.

The agro-tourism context played a crucial role in this process. By embedding geometric concepts within real, tangible environments such as measuring land plots, analyzing crop patterns, and calculating irrigation systems, students engaged in situated learning (Lave & Wenger, 1991). This approach situates mathematical reasoning within authentic experiences, allowing learners to construct meaning through participation and contextual understanding. Moreover, the strong visual and sensory elements of agro-tourism tasks activated embodied cognition (Lakoff & Núñez, 2000), where reasoning and abstraction are grounded in students' physical and perceptual interactions with the environment. For Generation Alpha—digital natives who learn best through interactive, visually rich, and contextually meaningful tasks—this combination proved particularly effective.

Hence, the agro-tourism-based digital worksheets not only facilitated understanding of geometric principles but also nurtured rational thinking by prompting students to interpret, justify, and evaluate solutions based on authentic contextual evidence. This demonstrates that contextual digital learning environments can bridge conceptual understanding and value formation, positioning rationalism as both a process of reasoning and an educational goal in mathematics learning for Generation Alpha.

The findings of this study confirm earlier evidence that contextualized learning environments can enhance students' reasoning and engagement in mathematics (Freudenthal, 1991; Gravemeijer & Terwel, 2000). However, this study extends prior work by demonstrating that digital worksheets integrating agro-tourism contexts can serve as an effective medium for fostering rational thinking—a value-oriented dimension rarely addressed in earlier PMRI or RME-based studies. Unlike prior research focusing mainly on conceptual understanding (e.g.,

Fauzan et al., 2024; Lestari et al., 2023; Palinussa et al., 2025; Prahmana et al., 2020; Sutarni et al., 2024; Wijaya et al., 2018; Zulkardi & Putri, 2019), the present study highlights how context-based digital materials can also encourage reflective justification and evaluation of reasoning, key indicators of rationalism.

Moreover, the results challenge assumptions that Generation Alpha's engagement with digital tools is purely recreational (Prensky, 2010), showing instead that when learning media are designed with authentic contexts, students can meaningfully connect digital interaction with cognitive reflection. These findings therefore not only support but also expand the theoretical framework of contextual mathematics learning by linking it explicitly with value-based reasoning. This comparative interpretation situates the study's contribution within the broader discourse on digital pedagogy, contextual learning, and mathematical rationalism, emphasizing its potential to bridge technological affordances and philosophical values in mathematics education.

The results of the study show that digital teaching materials developed to support rationalism values in students have several important characteristics. First, these teaching materials contain questions designed to encourage students to provide reasons to support the answers they give. This is in line with the view that the rationalism-based learning process emphasizes the importance of students' ability to think critically and put forward logical arguments in answering questions (Mutisyah et al., 2021). With questions that trigger students to think more deeply and present clear reasons, these teaching materials help develop high-level thinking skills, which is one of the main goals of rationalism-based education (Paul & Elder, 2020). Second, these teaching materials are packaged in a digital format that is easy for students to access and use. The use of these digital teaching materials is relevant to the development of information technology in the world of education, where ease of access and flexibility in use are important factors in increasing student involvement in the learning process (Brieger et al., 2020). Digital learning materials allow students to learn anytime and anywhere, giving them the freedom to manage their own learning time, which can ultimately improve learning outcomes (Selwyn, 2021).

Third, the digital learning materials developed in this study have been adapted to the characteristics of Generation Alpha students, known as a generation born in an environment surrounded by digital technology (Azman et al., 2021; Fitri et al., 2024; Harisman et al., 2025; Hernandez-de-Menendez et al., 2020; Marin & White, 2023; Meryansumayeka et al., 2019, 2020; Ramadan et al., 2025). Generation Alpha is the first generation to grow up with smart devices since birth, so they tend to be very adept at using technology and have a strong preference for interactive and digital-based learning (McCrinkle & Fell, 2020). The development of these digital learning materials is designed to accommodate the needs of Generation Alpha students, who are generally more accustomed to learning through digital media than traditional learning methods (de Guzman, 2024).

The characteristics of Generation Alpha, who tend to have a shorter attention span, due to being accustomed to fast and instant information, require learning materials that are designed to be interactive, interesting, and easily accessible. The digital learning materials created in this study have met these criteria because they are packaged in an easy-to-use format and offer a flexible learning experience. Students can access materials whenever and wherever

they are, allowing them to learn independently in a way that suits their learning style preferences (Alfaro et al., 2021).

In addition, the Alpha generation is known to have good multitasking skills and is more interested in multimedia-based learning that presents a combination of text, video, animation, and audio (Hutajulu et al., 2024). In this case, the digital teaching materials developed in this study have combined various media elements to increase student engagement in the learning process. Through the use of interactive and varied teaching materials, Alpha generation students can be more motivated to learn and understand the concepts taught better (Ziatdinov & Cilliers, 2021).

Fourth, the agrotourism context used in this digital teaching material also plays an important role in supporting students' understanding of geometry material. Real-world contexts, such as agrotourism, provide students with the opportunity to connect geometry concepts to practical situations they encounter every day. This supports the theory of contextual learning, where students find it easier to understand abstract concepts if they are linked to real experiences (Ginting et al., 2022). By applying geometry in the context of agrotourism, students can see direct applications of geometry concepts, such as measuring land area, calculating building volume, or designing patterns on agricultural land.

Agrotourism as a learning context also provides visual and practical experiences that strengthen students' understanding (Fauziah et al., 2016; Kadonsi, 2025; Kurniawan et al., 2025). Through direct observation of objects in the agrotourism environment, students can learn about geometric shapes and apply concepts such as symmetry, angles, and size to building structures, plants, or other elements in the environment (Duman & Oğuz, 2023). This direct interaction with the physical environment creates a more meaningful and relevant learning experience, which ultimately helps students understand geometry in greater depth.

The use of agrotourism also encourages project-based learning, where students can solve geometric problems related to agricultural land planning or development (Zhang, 2019). For example, students can be asked to design a garden layout considering the area, landform, and crop distribution. Such activities not only strengthen their understanding of geometry but also develop critical and creative thinking skills. Thus, the integration of the agrotourism context into digital learning materials provides a rich learning experience and helps students relate geometric concepts to real-world applications. This is in line with the constructivist learning approach, which emphasizes the importance of relevant and meaningful learning experiences (Deepa et al., 2022).

4. CONCLUSION

Based on the development process and implementation results, this study successfully identified the characteristics of a valid, practical, and effective digital worksheet that supports students' rational thinking skills. The validity aspect was demonstrated through expert evaluations indicating that the digital worksheet met pedagogical and contextual standards, including content accuracy, alignment with learning objectives, clarity of instructions, contextual relevance, and technical presentation, with only minor revisions recommended. The practicality aspect emerged from the one-to-one and small-group trials, where students were able to use the worksheet independently, navigate the task flow clearly, and show positive

engagement with the digital activities. Meanwhile, the effectiveness aspect was evident during classroom trials through students' responses and reasoning patterns, which reflected strengthened rational thinking behaviors such as logical justification, coherence in geometric reasoning, and reflective evaluation of their solutions.

The developed digital worksheet is characterized by tasks that encourage students to provide reasons to justify their answers, supported by an interactive design suited to the preferences of Generation Alpha, who are highly familiar with technology and favor flexible, multimedia-based learning. The integration of an agrotourism context makes geometric concepts more meaningful by connecting them to real-life applications, thereby enhancing students' understanding and critical thinking. Overall, the findings indicate that the digital worksheet meets the criteria of being valid, practical, and effective, and successfully supports the development of students' rational thinking skills in accordance with the aims of this research and development study.

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