Kognitif
Jurnal Riset HOTS Pendidikan Matematika
Volume- 5 No- 4 Page 1788 – 1804
ISSN 2776-9704 P-ISSN 2776-9984
https://doi.org/10.51574/kognitif.v5i4.4442

Android-Based Pisa-Type Questions in The Ramadhan Context to Know Students' Mathematical Thinking Abilities

Suci Indah Pratiwi, **Ratu Ilma Indra Putri**, **Somakim**

How to cite: Pratiwi, S. I., Putri, R. I. I., & Somakim, S. (2025). Android-Based Pisa-Type Questions in The Ramadhan Context to Know Students' Mathematical Thinking Abilities. *Kognitif: Jurnal Riset HOTS Pendidikan Matematika*, *5*(4), 1788–1804. https://doi.org/10.51574/kognitif.v5i4.4442

To link to this artcle: https://doi.org/10.51574/kognitif.v5i4.4442

Opened Access Article

Published Online on 31 December 2025

Submit your paper to this journal

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v5i4.4442 Volume 5, No 4, October - December 2025, pp. 1788 – 1804

Android-Based Pisa-Type Questions in The Ramadhan Context to Know Students' Mathematical Thinking Abilities

Suci Indah Pratiwi[1*], Ratu Ilma Indra Putri[2], Somakim[3]

[1,2,3]Department of Mathematics Education, Faculty of Teacher Training and Education, Universitas Sriwijaya

Article Info

Article history:

Received Nov 21, 2025
Accepted Dec 19, 2025
Published Online Dec 31, 2025

Keywords:

Research and Development
PISA Type Questions
Mathematical Thinking
Game Based Quantity Material

ABSTRACT

The increasing demand for assessing students' mathematical thinking skills in authentic and meaningful contexts, as emphasized by international assessments such as PISA, highlights the urgent need for context-based assessment instruments that are relevant to students' everyday experiences. In response to this gap, this study aimed to develop and examine the effectiveness of a PISA-type mathematics test set grounded in a real-world context, namely Ramadan, to assess junior high school students' mathematical thinking skills. This study employed design research in the form of a development study using Tessmer's formative evaluation model, which included expert review, one-to-one trials, and small-group trials. The research participants were eighth-grade students at SMP IT Al-Furqon Palembang. The developed assessment package consisted of 15 PISA-type mathematics items, test blueprints, item cards, and analytic scoring rubrics. Content, construct, and language validity were evaluated through expert reviews, while clarity and comprehensibility were examined through one-to-one trials with students. Practicality was assessed using a student questionnaire administered during the small-group trial. The results indicate that the developed test items achieved a high level of validity based on expert judgments and were considered practical, easy to understand, and effective to use by students. These findings suggest that the Ramadan-contextualized PISA-type test set is suitable for use as an assessment tool to support mathematics learning and evaluation at the junior high school level. The novelty of this study lies in the integration of a culturally meaningful religious context into PISA-type mathematics assessment, demonstrating how local and contextual values can be systematically embedded to enhance the relevance, validity, and pedagogical potential of mathematical thinking assessments.

Corresponding Author:

Suci Indah Pratiwi,
Department of Mathematics Education,
Faculty of Teacher Training and Education,
Universitas Sriwijaya,
Jl.Raya Palembang Prabumulih Km.32, Inderalaya, Ogan Komering Ilir.Kampus Palembang, Indonesia
Email: indahsuci806@gmail.com

Introduction

Mathematics equips students to interpret situations, model problems, and make decisions based on testable reasoning. Mathematical literacy requires students to use concepts, procedures, and reasoning to address real-world problems, rather than simply repeating algorithmic steps (Heyd-Metzuyanim et al., 2021; Susanta et al., 2023). This role aligns with the view that mathematics encompasses structures, relationships, and consistent ways of thinking (Ahmadpour et al., 2019; Kuper & Carlson, 2020a, 2020b; Wilkie, 2025). Mathematical thinking is also an important prerequisite because students need to mathematize, make predictions, and justify them (Rich et al., 2019; Sevimli, 2018). Kuper & Carlson, (2020a) places mathematical thinking within the interrelated abilities, skills, processes, and tasks of mathematics. Callingham & Siemon (2021) emphasizes that the development of mathematical thinking skills is gradual, so weaknesses in the early stages will hinder progress to later stages

The Programme for International Student Assessment (PISA) assesses the abilities of 15-year-old students in reading, mathematics, and science for real-life contexts. The OECD manages this program and conducts assessments periodically every three years (OECD, 2018). PISA does not assess memorization of content, but rather assesses the ability to apply knowledge to solve contextual problems. The number of participating countries increased from 41 at the start of the program to 81 in PISA 2022. PISA 2022 again places a significant emphasis on mathematics assessment, making mathematical literacy a primary focus (Habibi & Suparman, 2020; Tohir, 2019; Zulkardi et al., 2020). This positioning of mathematical literacy as a key indicator of the quality of mathematics learning in a country. PISA results show that Indonesia's performance in mathematics remains low and tends to decline. Indonesia's average mathematical literacy score in 2015 was 386, ranking 69th out of 72 countries. In 2018, the score dropped to 379, ranking 74th out of 79 countries. In 2022, the score dropped again to 366, ranking 70th out of 81 countries. These findings indicate that many students are not yet strong in understanding mathematical concepts and connecting ideas when faced with new situations (Chorney et al., 2024; Kafetzopoulos & Psycharis, 2022; Planas, 2020). Other studies also emphasize the weak reasoning in PISA-type questions because students rarely practice with tasks that require interpretation and justification (Qadry et al., 2022; Safrudiannur & Rott, 2019).

Classroom conditions exacerbate these problems because learning often focuses on routine procedures and similar exercises. Textbooks also often provide little space for solving real-world problems that align with the characteristics of PISA questions (Jäder et al., 2020; Rezat et al., 2021). Yet, students can develop PISA strategies if teachers habitually incorporate contextual problem-based activities in the classroom (Qadry et al., 2022). Therefore, developing PISA model questions needs to be part of learning improvements, not just an evaluation instrument. PISA questions require contexts close to students' lives so they can model situations meaningfully (Brown et al., 2020). Teachers need to design contexts that are familiar and relevant to students' environment to encourage mathematical literacy (Heyd-Metzuyanim et al., 2021; Susanta et al., 2023).

The Indonesian Realistic Mathematics Education (RME) approach provides a strong foundation for contextual learning and assignments. RME is rooted in Realistic Mathematics Education, which positions mathematics as a human activity and emphasizes guided reinvention (Charitas et al., 2023; Nolaputra et al., 2018). Treffers formulated the key characteristics of RME, namely the use of context, the use of models, student contributions, interactivity, and interconnectedness between topics. These characteristics align with the requirements of PISA questions, which demand contextual interpretation and progressive mathematization. Interactivity in RME can also be strengthened through collaborative learning, as students need to discuss strategies and evaluate their peers' reasoning (Ekowati et al., 2021;

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v5i4.4442 Volume 5, No 4, October - December 2025, pp. 1788 – 1804

Muslimin et al., 2020; Yilmaz, 2020). The practice of sharing tasks and jumping tasks helps students progress from basic strategies to more challenging ones.

Technological developments open up opportunities to package contextual activities in a more engaging and accessible way. Android-based media can help students learn through visuals, interactions, and rapid feedback, especially on material that requires a sense of context (Kurniasih et al., 2020). Educators also need to master technology to integrate media appropriately into learning (Hsieh et al., 2025; Utami et al., 2018; Zambak & Tyminski, 2020). One relevant form of interactive media is educational games because they can combine problems, challenges, and learning motivation (Kärki et al., 2022). Studies show that educational games can aid understanding of mathematical material and support improved learning outcomes if their design aligns with learning objectives (Nisa & Susanto, 2022). Therefore, the development of game-based PISA questions has the potential to become a more meaningful means of practicing mathematical literacy.

Context selection is key because it determines the proximity of the problem to students' experiences and influences the quality of their reasoning. PISA categorizes contexts into personal, occupational, societal, and scientific domains, so test designers need to choose contexts that are realistic for students. Ramadan offers a familiar context for many students in Indonesia and is rich in quantitative situations that can be modeled. This research focuses on developing questions on Quantity content, which includes numerical operations, measurement, ratios, percentages, and estimation in real-life situations (Hackenberg et al., 2021; Purnomo et al., 2022). Examples of relevant situations include calculating zakat (alms), shopping for Eid al-Fitr necessities, estimating the time to prepare takjil (breaking fast), the flow of people returning home (mudik), and data on Eid prayer congregations. Although research on the development of PISA questions has used various contexts such as pandemics, sports, local contexts, and Islamic values, studies that combine the context of Ramadan, Quantity content, and game formats are still limited (Utama et al., 2019).

Based on these needs, this study aims to develop game-based PISA model questions in the context of Ramadan for junior high school students. This study targets valid and practical question products for use as mathematical literacy practice activities in the classroom. This study also maps students' mathematical thinking skills through responses and problem-solving strategies in the developed questions. The focus of the context includes fasting and almsgiving, buying Eid cakes, zakat, the homecoming flow, and Eid prayer congregations to ensure the questions remain close to students' experiences. The research outputs are expected to help teachers provide mathematical literacy exercises that require contextual interpretation, modeling, and evaluation of results. Thus, this study offers an alternative solution to reduce procedural learning habits and improve students' readiness to face PISA-type questions..

Method

Types of research

This research uses a development research type . *The* goal is to develop Android-based Ramadan-context PISA type questions using the PISA 2022 *framework to improve junior high school students' mathematical thinking skills. This research uses two main stages, namely Preliminary* , Preparation, Developing 15 contextual PISA questions (*Quantity content), and* other research instruments . Analyzing student characteristics (heterogeneous students of SMP IT Al-Furqon), curriculum (Independent Curriculum Phase D), and PISA question characteristics (to design *sharing tasks* and *jumping tasks*). Creating initial drafts of questions (covering cognitive levels C2–C4 and C4–C6), grids, rubrics, and teaching modules (producing Prototype 1). *Formative Evaluation* aims to test and refine questions through *self-evaluation* , *expert review*, *one-to-one* (individual), *small group* , and *field tests* . Data collection instruments include written tests, observations, and interviews. The indicators used in this study are based on three mathematical thinking processes, as shown in Table 1.

Table 1. Indicators Ability Think Mathematical

No	Indicator	Descriptor
1	*Specializing*	Identify problems, Manage and implement various strategies
2	*Generalizing*	Reflection of the designed ideas/concepts, Exposing the scope of the results obtained
3	*Conjecturing*	Examine the reasons why the results obtained will appear, Create a pattern from the results obtained and Create the opposite of the pattern that has been formed

Instrument

The instruments used to collect data included written tests, observations, and interviews. The indicators measured were based on three mathematical thinking processes (referred to in a table). The instruments used in this study consisted of PISA questions, grids, question cards, and assessment rubrics. All of these instruments were specifically designed to suit the characteristics of junior high school students' mathematical thinking abilities using the Ramadan context. The main focus of the developed *prototype* was the question items, which must meet three main criteria: Content (the mathematical material being tested); Construct (the structure and form of the questions); and Language (the clarity and accuracy of language use). These three criteria are aspects that will be validated by validators or experts to ensure the quality of the instrument. The following are th e PISA questions that have been developed.

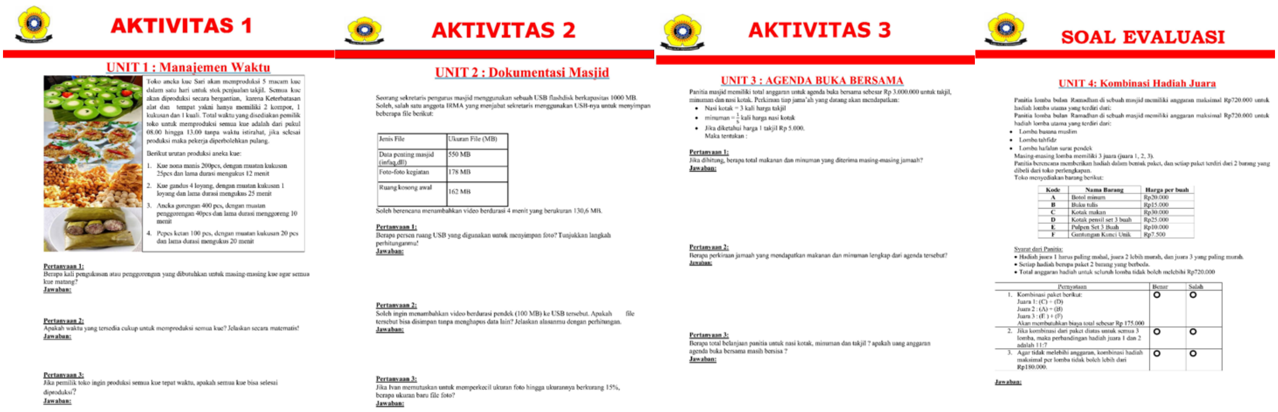

Figure 1. PISA Unit 1-3 Questions and Evaluation

Procedure

This study follows the design research model of the development studies. This procedure is divided into two main stages: Preliminary Study and Formative Evaluation. (The author refers to Figure 2 for a visualization of this research flow.)

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v5i4.4442 Volume 5, No 4, October - December 2025, pp. 1788 – 1804

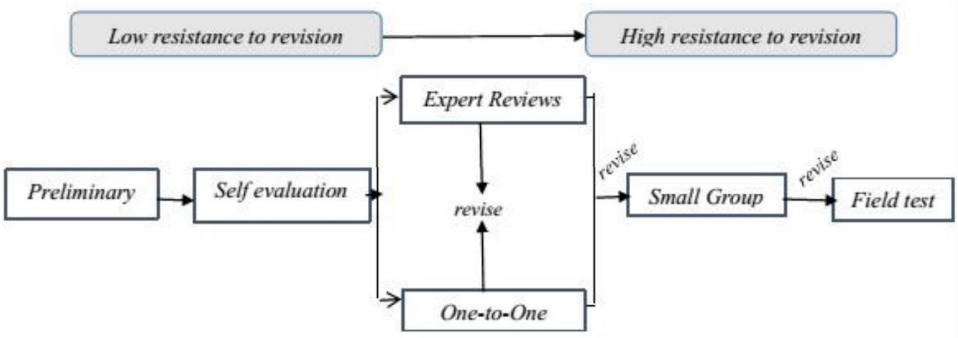

Figure 2. Channel study development

Stage Studies Introduction

In this initial stage, researchers conducted a needs analysis through a literature and curriculum review to confirm the importance of developing contextual questions that could measure junior high school students' mathematical thinking skills. The results of this analysis were used to develop an initial draft of the Ramadan-related PISA questions and their supporting tools (grids, question cards, and scoring rubrics).

Stage Evaluation Formative

Stage Evaluation consists of from a number of subprocess evaluation, namely: Expert Review, to assess the validity aspects of the content, construct, and language of the questions developed. Three validators (material, media, and language experts) provided assessments and suggestions for improvement. One-to-One Evaluation, For see practicality And understanding question by three students with different abilities (high, medium, low). Small Group Evaluation, to test the practicality and consistency of the questions through a limited trial with six students. Student responses, work results, and interviews were used as the basis for further revisions. Each stage was structured to ensure the questions met the criteria for validity and practicality.

Data analysis

The collected data was analyzed descriptively quantitatively (in the form of numbers and percentages) and qualitatively (in the form of suggestions and descriptions), adjusted to the instrument and measurement objectives.

Validity Analysis

Data from the expert review were analyzed using a rating scale to generate percentage scores for three aspects: content, construct, and language. The validity criteria used to classify the percentage scores refer to the established classification (Hodiyanto, 2020), which can be seen in Table 2.

Practicality Analysis

Data on the practicality of the instrument were collected through student questionnaires and interviews. This data was processed into percentage scores, which were then classified into five categories (ranging from Very Practical to Not Practical), using classification guidelines similar to those used in the validity analysis.

Table 2. Validity Criteria

Percentage %	Criteria Validity
80% < Score ≤ 100%	Very Valid
60% < Score ≤ 80%	Valid
40% < Score ≤ 60%	Enough Valid
20% < Score ≤ 40%	Not enough Valid
0% < Score < 20%	No Valid

Table 3. Practicality Criteria

Percentage %	Criteria Practicality
80% < Score ≤ 100%	Very Practical
60% < Score ≤ 80%	Practical
40% < Score ≤ 60%	Enough Practical
20% < Score ≤ 40%	Not enough Practical
0% < Score ≤ 20%	No Practical

Research Findings

Preliminary Stage

In this initial phase, researchers successfully developed 15 PISA-type questions using the Ramadan context. In addition to the questions, researchers also developed comprehensive supporting instruments, including a grid, question cards, and a scoring rubric. These tools were then prepared for validation by experts.

Stage Formative Evaluation

This stage begins with an expert validation process involving two mathematics education lecturers, namely Mrs. Dr. Jayanti, M.Pd. (Material Expert from PGRI Palembang University) and Mr. Ali Syahbana, M.Pd. (Material Expert from Muhammadiyah Palembang University). Validation was carried out through direct discussions and filling out assessment sheets by the validators between October 27 and November 1, 2025. Input, suggestions, and responses from the experts were recorded in the validation sheet to be used as a reference in revising and refining the questions. Simultaneously, an individual trial (*One-to-One*) was also conducted on three students. The purpose of this trial was to assess the practicality of the question prototype, as well as to ensure that the questions were easy to use and understand by students. Each student was asked to provide opinions and suggestions. Student suggestions and comments were analyzed to improve the question prototype . The results obtained from the expert review and individual trial stages will be further explained in Figure 3 and Figure 4.

Figure 3. One-to-one stage

Figure 4. Expert Review stage

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v5i4.4442 Volume 5, No 4, October - December 2025, pp. 1788 – 1804

Table 4. Content Validation

No	Validation Indicator	Percentage
1	Context Which used relevant question PISA type	91.7 %
2	Level difficulty context in accordance with cognitive level junior high school students	83.3 %
3	Questions Which developed truly measure ability mathematical thinking	75%
4	Questions the push student For think critical And creative in finding a solution	83.3%
5	Use context This can increase motivation And interest student in study mathematics or related subjects	91.7 %
6	Level difficulty question varies And in accordance with objective measurement	83.3%
	Average	84.7

Table 5. Construction Validation

No	Validation Indicator	Percentage
1	Objective development question PISA type with context Ramadan clear and measurable	83.3 %
2	The indicators of mathematical thinking ability used in developing questions are in accordance with the objectives and constructs to be measured.	75 %
3	Questions Which developed covers various aspect important in mathematical thinking	75%
4	Level cognitive Which sued by every question in accordance with level cognitive development of junior high school students	91.7 %
5	The question format is appropriate to the mathematical thinking construct to be measured and allows students to demonstrate their thinking processes.	91.7 %
6	Question No too easy or too difficult so that No can measure mathematical thinking skills effectively	83.3%
	Average	83.3

Table 6. Language Validation

No	Validation Indicator	Percentage
1	The language that used in title and clear, easy questions understood, and unambiguous for junior high school students	91.6%
2	Sentences in question arranged in a way effective And No convoluted	83.3 %
3	Vocabulary And structure sentence Which used in accordance with language development level of junior high school students	83%
4	No There is use Language Which too formal or too informal Which can confuse students	83.3 %
5	Language Which used neutral And No contain element bias to certain student groups	75%
6	Symbol And writing mathematics it's right	83.3%
	Average	**8 3.3 %**

Table 7. Validation Results

No	Aspect	Percentage	Criteria
1	Content	8 4.7 %	Very Valid
2	Construct	8 3.3 %	Very Valid
3	Language	8 3.3 %	Very Valid
	Average	83.7%	Very Valid

Based on the scores from Tables 4, 5, 6, and 7, the developed PISA-type test set with a Ramadan context achieved an average validity percentage score of 83.7%. This score places the test in the Very Valid category. The validity breakdown per aspect is as follows: Content (84.7%), Construct (83.3%), and Language (83.3%). Although the results are highly valid, the experts provided comments and suggestions for improvement that must be followed up. The validators emphasized that the Ramadan context is relevant and effective in increasing student engagement because it aligns with social phenomena they are already familiar with.

After initial revisions, a pilot test was conducted on three students with different abilities (low, medium, and high). In general, students rated the questions as interesting, realistic, and easy to understand . Students found the Ramadan context engaging because it felt like *a game simulation* and relevant to the real world. These results indicate that the developed questions not only function to measure numerical ability but also facilitate students' thinking processes , in line with the objectives of developing context-based questions (Komalasari et al., 2019; Indriani et al., 2020).

Stage Small Group

This phase involved six students with varying abilities. Students were given 120 minutes to complete Prototype 2 (which had been revised from the previous phase), followed by an interview. The purpose of analyzing the results of the work and interviews was to see the consistency and practicality of Prototype 2. This consistency is necessary to ensure the questions are suitable for use. Based on the scores and analysis of answers, Prototype 2 had a positive impact on students' level of understanding. The majority of students were able to identify known and asked information, and plan and implement problem solving using their chosen strategies, although there were still some students who made errors. Results at the small group stage, you can see Figure 5.

Figure 5. Small Group Stages

Group 1
Interviewer: "How according to "Do you have questions on unit 2, namely about mosque documentation ?" Student A: “When I saw the table, I got a bit dizzy.” Student B: "Just imagine, our cellphone memory can be manipulated and it's easy." Student C: “Not bad. It’s not difficult, but it’s not easy either. You can do it slowly. ”
Interviewer: "Question where Which according to you most difficult or make Confused?" Student B: "Thank God, this is for everyone, is it difficult or easy?" Student A: "I get a headache just imagining it all, but the most difficult thing is number 2, which also asks for the reason for the calculation." Student C: “number 1 is not bad because I forgot how to calculate percentages .”

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v5i4.4442 Volume 5, No 4, October - December 2025, pp. 1788 – 1804

Interviewer: "You Like do it question This with or more nice Alone?" Student A: "With, Sis. The problem is if Confused Can ask Friend." Student B: "We had time different opinion question number 3, so we discussion Keep going choose answer together." Student C: "I learned another way from my friend. It was fun."
Interviewer: "According to you guys, question This more interesting than question in book?" Student C: "Far more interesting. The problem is real, kayak events in everyday life ." Student A: "I So thinking if Later open business alone, count kayak This is very useful ." Student B: "Cool, ma'am. Even though it's difficult, it's interesting and makes my brain work out."
Group 2
Interviewer: "The story about mosque documentation , according to you suitable No For lesson mathematics?" Student D: "That's right, Sis. Because it makes us understand that mathematics is useful." Student E: "I So understand Why must learn file size " Student F: "I Like Because The context is like HP memory ."
Interviewer: "There is question Which most you Like?" Student D: "Which question number 1 is easy." Student E: "I like question number 1 too, because you can answer it in your own way." Student F: "Question number 3 is also good, reducing the size of the photo is normal ."
Interviewer: "What you feel difficulty time discussion?" Student D: "Sometimes Confused The same term kayak 'percentage'." Student E: "But if we are in a group, we can help explain." Student F: "I usually ask to friend Which more understand. Nice Work group."
Interviewer: "If question kayak like this given Again Sunday front, you Want to do it?" Student D: "Want to very, Sis. The problem is different from Usually." Student E: "As long as you do it as a group, okay?" Student F: "Me too want to make question challenge IRMA at the mosque near my house. Can, Sis?"

Table 8. Practicality Indicators

No	Practicality Indicator	Percentage	Criteria
1	Questions Which served easy understood.	83.3%	Very Practical
2	Instructions workmanship question delivered with clear.	79.2%	Practical
3	Question use Language Which in accordance with level of understanding of junior high school students.	83.3%	Very Practical
4	Illustration or data in question PISA Ramadan context supports understanding of questions.	83.3%	Very Practical
5	Time Which provided Enough For solve all the questions.	75%	Practical
6	Question can done without help Teacher in a way direct.	75%	Practical
7	Question push student think critical And creative.	87.5%	Very Practical
8	Question too difficult For used in class.	75%	Practical
9	Language in question confusing student.	83.3%	Very Practical
10	Context Ramadan make student difficulty understand the question.	75%	Practical
	Average	**80%**	**Practical**

Small group phase, students not only demonstrated improved understanding (as mentioned previously), but were also able to discuss problem-solving strategies and relate mathematical concepts (such as ratio, volume, and percentage) to the context of Ramadan. Motivation: Students demonstrated high enthusiasm because the context was close to their lives.

This aligns with research that suggests that popular contexts increase motivation and interest in learning. The questions were considered challenging yet realistic. Data from the questionnaire showed that the average practicality score for PISA-type questions in the context of Ramadan was 80%. This score placed the questions in the Practical category. Students rated the instructions as clear, the language easy to understand, the illustrations supportive, and the questions able to be worked on independently. These questions were proven to encourage critical and creative thinking and provided opportunities for students to explore various problem-solving strategies.

Discussion

Characteristics of PISA Type Questions and Quantity Content Activities in a Valid and Practical Ramadan Competition Context

This research produced a set of PISA-type questions on Quantity content within the context of Ramadan to activate junior high school students' mathematical literacy. The questions went beyond contextual narratives, but required students to select relevant information, model situations, and interpret results. This focus aligns with PISA's orientation, which assesses the ability to use mathematics in real-world situations (OECD, 2018). Therefore, product quality needed to be demonstrated through content, construct, and language validity, as well as practicality for classroom use. The formative evaluation framework supported this objective because item revisions were based on iterative expert input and student responses. Thus, the developed product could be justified theoretically and empirically.

Expert review results indicate the instrument is in the highly valid category with an average of 93.85 percent, with scores in the content, construct, and language aspects in the high range. This evidence indicates the suitability of the Quantity content and the appropriateness of the cognitive demands for eighth-grade students. However, expert validity does not automatically guarantee that all items function optimally when completed by students. One-to-one findings in Activity 1 Unit 1 number 1 show variations in understanding, especially in less effective sentence sections. This variation indicates initial obstacles arise at the stage of understanding the stimulus and grasping task demands. This pattern is consistent with the characteristics of PISA questions, where errors often occur at the stage of extracting information and building an initial model (Tohir, 2019; Zulkardi et al., 2020).

The revisions to Prototype 2 can be understood as strengthening the stimulus function and clarifying the task demands. PISA-like questions demand concise, clear stimuli that guide the mathematization process. Long or ambiguous sentences encourage students to process all numbers without selection, thus constructing erroneous models. The language refinement helps reduce the burden of understanding the narrative, allowing students to shift their attention to the quantitative structure (Hackenberg et al., 2021; Mkhatshwa, 2020; Sievert et al., 2021). The included tables and illustrations serve as representational scaffolding that helps students shift context to mathematical models. This argument also aligns with the principle of progressive mathematization in the RME and PMRI traditions, which position models as a bridge from the informal to the formal (Charitas et al., 2023; Nolaputra et al., 2018).

Practicality in the small group stage demonstrated that the instrument could be used reasonably by students of varying abilities. A questionnaire score of 80 percent in the practical category indicated that students considered the questions easy to read, the context familiar, and supporting information such as tables helpful in the process. The continuous narrative also maintained contextual coherence between items, so students did not need to re-adapt for each question. This helped students focus on quantitative decisions, rather than on understanding new narratives. Practicality in the test kit can be understood as ease of use without heavy

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v5i4.4442 Volume 5, No 4, October - December 2025, pp. 1788 – 1804

reliance on teacher guidance, while still maintaining the demand for thinking (Habsyi et al., 2022). Thus, practicality is not synonymous with "easy questions," but rather "accessible questions to stimulate literacy processes."

Empirical validity results show high item-total correlations ranging from 0.7033 to 0.9088. This finding indicates that each item contributes consistently to the total score in the test sample. However, the sample size of n = 22 should be noted because correlation estimates in small samples can be less stable. The reliability section also needs to be reported and interpreted rigorously. A Cronbach's Alpha value of $r_{11} = 0.374$ cannot be categorized as very high in general practice, so the calculation and reporting need to be re-examined, or the interpretation needs to be adjusted. If this value is correct, low reliability may be caused by the multidimensional nature of the instrument, too wide a variation in difficulty levels, or an unstable scoring procedure. Consequently, further reliability testing on a larger sample is an important agenda before widespread use.

Overall, the test set demonstrated strengths in expert validity and student practicality, as well as initial evidence of item coherence through item-total correlations. The Ramadan context provides a rich quantitative situation with realistic numerical decisions, measurements, ratios, percentages, and estimates. The strength of the design lies in the context's ability to facilitate modeling and interpretation, rather than simply telling a story. However, measurement stability through reliability needs to be strengthened through more adequate follow-up testing. With this emphasis, the product can be positioned as a valid and practical mathematical literacy instrument, with a note on strengthening reliability for broader application.

The Potential Effects of PISA Question Types and Quantity Content Activities in the Context of Ramadan on Students' Mathematical Literacy Skills

The Prototype 3 field test was conducted to assess the instrument's potential effects , namely initial evidence that the developed tasks foster students' mathematical literacy processes. Within the PISA framework, mathematical literacy encompasses the processes of formulating problems, using mathematics, and interpreting and evaluating results (Habibi & Suparman, 2020; Tohir, 2019; Zulkardi et al., 2020). Therefore, the discussion should emphasize evidence of these processes evident in students' strategies and responses. The indicators used in this study, such as problem understanding, strategies, reasoning, and communication, can be positioned as operational elaborations of the PISA literacy process (Qadry et al., 2022; Safrudiannur & Rott, 2019). Problem understanding and information selection represent the formulating process. Strategies and procedure execution represent the using process. Reasoning and communication represent the interpreting and evaluating processes. This mapping makes reporting more consistent with the instrument's purpose as a PISA-like item.

In the formulation stage, the Ramadan context helps students recognize the situation and identify relevant quantitative quantities. Student responses, which include specifying what is known and what is asked, and using tables or sketches, demonstrate a transition from narrative to modeling. Supporting tables and illustrations encourages students to focus on data structures and quantitative relationships. However, some students potentially struggle by entering all information without selecting or connecting quantities incorrectly. This difficulty is consistent with a common problem with PISA questions, namely that obstacles arise from the initial understanding of the stimulus and model construction (Ekowati et al., 2021; Putri et al., 2022; Voigt et al., 2020). Therefore, the quality of questions can be assessed by the extent to which the stimulus helps students select information and construct an appropriate model.

In the Using Mathematics stage, the Quantity item requires students to select relevant operations and strategies to solve problems. Responses that demonstrate planning, consistent units, and structured calculation steps indicate meaningful use of mathematics. Conversely, errors in ratios, unit conversions, or percentages indicate that students' difficulties lie not only in understanding the story, but also in controlling quantities. This pattern is important because it confirms that the developed task tests the ability to apply mathematics in context, not simply through routine procedures. This result is relevant to the finding that students are often unfamiliar with contextual tasks that require mathematical decisions, as learning and textbooks tend to be more procedural (Armiati et al., 2022; Putranto & Marsigit, 2018). Thus, the potential effect of the instrument is reflected in the emergence of more adaptive modeling strategies and procedure selection.

At the interpreting and evaluating stage, the Ramadan context offers a strong opportunity because calculation results can be contextually tested for reasonableness. Responses that present conclusions in the context, explain the rationale for steps, or check the reasonableness of results indicate mathematical evaluation. However, the tendency to stop at numerical results without interpretation also needs to be recognized as a persistent barrier. This barrier is common in mathematical literacy because students often separate the calculation process from the meaning of the results. Context-based instruments have the potential to strengthen this stage, especially if items are designed to force students to assess the logicality of answers (Rezat et al., 2021). Therefore, the potential impact assessed is not simply the number of correct answers, but also the improvement in the quality of reasoning and the relevance of the results to the situation.

These potential effects can be explained through the mechanisms of task design. A familiar context reduces the burden of understanding the story, allowing students to model and evaluate outcomes. A continuous narrative maintains contextual consistency across items, allowing students to focus on varying quantitative demands within the same problem world. If learning involves discussion or group work, interaction can help students validate strategies and refine interpretations, particularly during the evaluation phase. Activities that require students to explain steps and outcomes also have the potential to encourage reflection and metacognition (Hartmann et al., 2024; Ilyas et al., 2019). Thus, the observed potential effects have a logical mechanistic basis and align with the literature.

The closing section of the discussion should emphasize limitations and an agenda for further research. Generalizability is still limited because the field test was conducted in a single school and the number of empirical test subjects was relatively small. The instrument's reliability needs to be strengthened through testing on a larger sample and more robust item analysis for PISA-like instruments. The Ramadan context also has the potential to benefit students who are very familiar with the activities, so testing in alternative contexts is needed to assess transfer. Furthermore, the use of the instrument as a routine practice in learning requires further research to assess its impact on sustainable literacy development. Clarifying these limitations and the follow-up plan is crucial to ensure the research contribution is robust, realistic, and ready to be tested on a broader scale.

Conclusion

This research produced a set of PISA-type mathematics problems on Quantity content with a Ramadan context that were structured into four activity and evaluation units. Expert assessments showed the device met valid criteria in terms of content, construct, and language, while small group testing demonstrated the device was practical because the stimulus was easy to understand, the context was familiar, and the tables and illustrations helped with representation and modeling. Field testing provided initial evidence that the device fostered mathematical literacy processes according to the PISA framework, particularly at the stages of formulating and using mathematics, as reflected in the achievement of the understanding indicators (76.52 percent) and strategies (76.14 percent). However, analysis of student responses also revealed significant weaknesses, namely that some students were not yet consistent in interpreting results contextually and were not yet strong in constructing logical reasons to support mathematical decisions, so the evaluation and justification stages still need to be strengthened.

The limitations of this study lie in the limited scope of the trial, which was limited to a single school and the relatively small number of empirical test subjects, so the generalizability of the findings is not yet strong. Furthermore, the internal consistency of the instrument needs to be more rigorously reported and strengthened through reliability testing on a larger sample and item analysis more appropriate for PISA-like instruments. The highly familiar context of Ramadan also has the potential to benefit certain students, so caution is needed when interpreting literacy achievement as a contextual effect, rather than solely mathematical ability. Furthermore, the evidence presented is a potential effect based on response patterns, and therefore cannot yet be interpreted as a causal effect as in an experimental design.

Future research is recommended to expand the pilot testing to several schools with different characteristics to strengthen the external validity and stability of the measurement. Researchers also need to conduct a more in-depth examination of the reliability and quality of the items, including mapping the items' suitability to the PISA literacy process and analyzing student errors in the interpretation and evaluation stages. Teachers are advised to use this tool as a routine exercise in learning, accompanied by class discussions that require reasoning, checking the reasonableness of answers, and mathematical communication to address students' weaknesses in the justification aspect. Developing contexts other than Ramadan is also recommended to test the transfer of mathematical literacy in diverse situations and ensure the tool remains relevant to a broader student population.

Conflict of Interest

The researcher revealed that there was no conflict interest.

Authors' Contributions

The first author, S.I.P., contributed as the researcher, collecting data and discussing the results. The other authors, R.I.I.P. and S., participated in revising and refining this article. The total percentage of contributions to the conceptualization, writing, and correction of this article is as follows: S.I.P. 70%, R.I.I.P.: 15%, and S.: 15%.

Data Availability Statement

The authors state that the data supporting the findings of this study will be made available by the corresponding author, [S.I.P.], upon reasonable request.

References

Ahmadpour, F., Reid, D., & Fadaee, M. R. (2019). Students ' ways of understanding a proof. *Mathematical Thinking and Learning*, *21*(02), 1–18. https://doi.org/10.1080/10986065.2019.1570833

Armiati, Fauzan, A., Harisman, Y., & Sya'Bani, F. (2022). Local instructional theory of probability topics based on realistic mathematics education for eight-grade students. *Journal on Mathematics Education*, *13*(4), 703–722. https://doi.org/10.22342/jme.v13i4.pp703-722

Brown, R. E., Weiland, T., & Orrill, C. H. (2020). Mathematics Teachers' Use of Knowledge Resources When Identifying Proportional Reasoning Situations. *International Journal of Science and Mathematics Education*, *18*(6), 1085–1104. https://doi.org/10.1007/s10763-019-10006-3

Callingham, R., & Siemon, D. (2021). Connecting multiplicative thinking and mathematical reasoning in the middle years. *Journal of Mathematical Behavior*, *61*(December 2020), 100837. https://doi.org/10.1016/j.jmathb.2020.100837

Charitas, R., Prahmana, I., Arnal-palacián, M., & Risdiyanti, I. (2023). Trivium curriculum in Ethno-RME approach : An impactful insight from ethnomathematics and realistic mathematics education. *Jurnal Elemen*, *9*(January), 298–316.

Chorney, S., Evans, K. R., & Staples, M. (2024). Conceptualizing reasoning practices in the context of sociomathematical issues. *Journal of Mathematical Behavior*, *73*. https://doi.org/10.1016/j.jmathb.2024.101124

Ekowati, D. W., Azzahra, F. Z., Saputra, S. Y., & Suwandayani, B. I. (2021). Realistic mathematics education (RME) approach for primary school students' reasoning ability. *Premiere Educandum : Jurnal Pendidikan Dasar Dan Pembelajaran*, *11*(2), 269. https://doi.org/10.25273/pe.v11i2.8397

Habibi, H., & Suparman, S. (2020). Literasi Matematika dalam Menyambut PISA 2021 Berdasarkan Kecakapan Abad 21. *JKPM (Jurnal Kajian Pendidikan Matematika)*, *6*(1), 57. https://doi.org/10.30998/jkpm.v6i1.8177

Habsyi, R., R. M. Saleh, R., & Isman M. Nur. (2022). Pengembangan E-LKPD Berbasis Guided Dicovery Learning untuk Meningkatkan Kemampuan Berpikir Kritis Siswa. *Kognitif: Jurnal Riset HOTS Pendidikan Matematika*, *2*(1), 1–18. https://doi.org/10.51574/kognitif.v2i1.385

Hackenberg, A. J., Aydeniz, F., & Jones, R. (2021). Middle school students ' construction of quantitative unknowns ⋆. *Journal of Mathematical Behavior*, *61*(December 2020), 100832. https://doi.org/10.1016/j.jmathb.2020.100832

Hartmann, L. M., Schukajlow, S., Niss, M., & Jankvist, U. T. (2024). Preservice teachers' metacognitive process variables in modeling-related problem posing. *Journal of Mathematical Behavior*, *76*(September), 101195. https://doi.org/10.1016/j.jmathb.2024.101195

Heyd-Metzuyanim, E., Sharon, A. J., & Baram-Tsabari, A. (2021). Mathematical media literacy in the COVID-19 pandemic and its relation to school mathematics education. *Educational Studies in Mathematics*, *108*(1–2). https://doi.org/10.1007/s10649-021-10075-8

Hsieh, F. J., Wang, T. Y., Hsieh, C. J., & Chu, C. T. (2025). The relationships of preservice teachers' dispositions and noticing of technology-integrated mathematics teaching activities. *ZDM - Mathematics Education*, *57*(6), 1139–1152. https://doi.org/10.1007/s11858-025-01727-7

Ilyas, M., Ma'Rufi, & Basir, F. (2019). Students metacognitive skill in learning mathematics through cooperative based emotional intelligence. *Journal of Physics: Conference Series*, *1397*(1). https://doi.org/10.1088/1742-6596/1397/1/012089

Jäder, J., Lithner, J., & Sidenvall, J. (2020). Mathematical problem solving in textbooks from twelve countries. *International Journal of Mathematical Education in Science and Technology*, *51*(7), 1120–1136. https://doi.org/10.1080/0020739X.2019.1656826

https://doi.org/10.51574/kognitif.v5i4.4442 Volume 5, No 4, October - December 2025, pp. 1788 – 1804

Kafetzopoulos, G. I., & Psycharis, G. (2022). Conceptualization of function as a covariational relationship between two quantities through modeling tasks. *Journal of Mathematical Behavior*, *67*(July), 100993. https://doi.org/10.1016/j.jmathb.2022.100993

Kärki, T., McMullen, J., & Lehtinen, E. (2022). Improving rational number knowledge using the NanoRoboMath digital game. *Educational Studies in Mathematics*, *110*(1), 101–123. https://doi.org/10.1007/s10649-021-10120-6

Kuper, E., & Carlson, M. (2020). Foundational ways of thinking for understanding the idea of logarithm. *Journal of Mathematical Behavior*, *57*(January 2019), 100740. https://doi.org/10.1016/j.jmathb.2019.100740

Kurniasih, S., Darwan, D., & Muchyidin, A. (2020). Menumbuhkan Kemandirian Belajar Matematika Siswa Melalui Mobile Learning Berbasis Android. *Jurnal Edukasi Matematika Dan Sains*, *8*(2). https://doi.org/10.25273/jems.v8i2.7041

Mkhatshwa, T. P. (2020). Calculus students' quantitative reasoning in the context of solving related rates of change problems. *Mathematical Thinking and Learning*, *22*(2), 139–161. https://doi.org/10.1080/10986065.2019.1658055

Muslimin, Indra Putri, R. I., Zulkardi, & Aisyah, N. (2020). Learning integers with realistic mathematics education approach based on islamic values. *Journal on Mathematics Education*, *11*(3), 363–384. https://doi.org/10.22342/JME.11.3.11721.363-384

Nisa, M. A., & Susanto, R. (2022). Pengaruh Penggunaan Game Edukasi Berbasis Wordwall Dalam Pembelajaran Matematika Terhadap Motivasi Belajar. *JPGI (Jurnal Penelitian Guru Indonesia)*, *7*(1). https://doi.org/10.29210/022035jpgi0005

Nolaputra, A. P., Wardono, & Supriyono. (2018). Analisis Kemampuan Literasi Matematika pada Pembelajaran PBL Pendekatan RME Berbantuan Schoology Siswa SMP. *Prisma, Prosiding Seminar Nasional Matematika*, *1*.

OECD. (2018). *Programme for International Students Assesment (PISA) Result From PISA 2018*.

Planas, N. (2020). How specific can language as resource become for the teaching of algebraic concepts? *ZDM - Mathematics Education*, *53*(2), 277–288. https://doi.org/10.1007/s11858-020-01190-6

Purnomo, Y. W., Pasri, Aziz, T. A., Shahrill, M., & Prananto, I. W. (2022). Students' failure to understand fraction multiplication as part of a quantity. *Journal on Mathematics Education*, *13*(4), 681–702. https://doi.org/10.22342/jme.v13i4.pp681-702

Putranto, S., & Marsigit, M. (2018). Is it Effective using Peer Tutoring with Realistic Mathematics Education Approach to Improve Slow Learners' Mathematics Attitudes? *International Journal on Emerging Mathematics Education*, *2*(2). https://doi.org/10.12928/ijeme.v2i2.10487

Putri, N. S., Juandi, D., & Jupri, A. (2022). The implementation effect of realistic mathematics education and contextual teaching and learning approaches on the students' mathematical communication ability: A meta-analysis. *Al-Jabar : Jurnal Pendidikan Matematika*, *13*(2). https://doi.org/10.24042/ajpm.v13i2.13562

Qadry, I. K., Dessa, A., & Aynul, N. (2022). Analisis Kemampuan Literasi Matematika Siswa Dalam Menyelesaikan Soal Pisa Konten Space and Shape Pada Kelas IX SMP Negeri 13 Makassar. *Jurnal Matematika Dan Aplikasinya*, *2*(2).

Rezat, S., Fan, L., & Pepin, B. (2021). Mathematics textbooks and curriculum resources as instruments for change. *ZDM – Mathematics Education*, *53*(6), 1189–1206. https://doi.org/10.1007/s11858-021-01309-3

Rich, K. M., Yadav, A., & Schwarz, C. V. (2019). Computational thinking, mathematics, and science: Elementary teachers' perspectives on integration. *Journal of Technology and Teacher Education*, *27*(2), 165–205.

Safrudiannur, & Rott, B. (2019). The different mathematics performances in PISA 2012 and a curricula comparison: enriching the comparison by an analysis of the role of problem solving in intended learning processes. *Mathematics Education Research Journal*, *31*(2), 175–195. https://doi.org/10.1007/s13394-018-0248-4

Sevimli, E. (2018). Understanding students' hierarchical thinking: A view from continuity, differentiability and integrability. *Teaching Mathematics and Its Applications*, *37*(1), 1–16. https://doi.org/10.1093/teamat/hrw028

Sievert, H., van den Ham, A. K., & Heinze, A. (2021). The role of textbook quality in first graders' ability to solve quantitative comparisons: a multilevel analysis. *ZDM - Mathematics Education*, *53*(6), 1417–1431. https://doi.org/10.1007/s11858-021-01266-x

Susanta, A., Sumardi, H., Susanto, E., & Retnawati, H. (2023). Mathematics literacy task on number pattern using Bengkulu context for junior high school students. *Journal on Mathematics Education*, *14*(1), 85–102. https://doi.org/10.22342/JME.V14I1.PP85-102

Tohir, M. (2019). Hasil PISA Indonesia Tahun 2018 Turun Dibanding Tahun 2015 (Indonesia's PISA Results in 2018 are Lower than 2015). *Open Science Framework*, *2*.

Utama, F. F., Rais, W. A., & -, S. (2019). An Ethnolinguistic Study in the Names of Salt Farming Tools in Rembang District. *Humaniora*, *10*(2), 167. https://doi.org/10.21512/humaniora.v10i2.5623

Utami, T. N., Jatmiko, A., & Suherman, S. (2018). Pengembangan Modul Matematika dengan Pendekatan Science, Technology, Engineering, And Mathematics (STEM) pada Materi Segiempat. *Desimal: Jurnal Matematika*, *1*(2), 165. https://doi.org/10.24042/djm.v1i2.2388

Voigt, M., Fredriksen, H., & Rasmussen, C. (2020). Leveraging the design heuristics of realistic mathematics education and culturally responsive pedagogy to create a richer flipped classroom calculus curriculum. *ZDM - Mathematics Education*, *52*(5), 1051–1062. https://doi.org/10.1007/s11858-019-01124-x

Wilkie, K. J. (2025). 'Things haven't gone the way I thought they'd go': secondary mathematics teachers talk about trialling a problem-solving pedagogy. *Journal of Mathematics Teacher Education*. https://doi.org/10.1007/s10857-025-09709-y

Yilmaz, R. (2020). Prospective Mathematics Teachers ' Cognitive Competencies on Realistic Mathematics Education. *Journal on Mathematics Education*, *11*(1), 17–44.

Zambak, V. S., & Tyminski, A. M. (2020). Examining mathematical technological knowledge of pre-service middle grades teachers with Geometer's Sketchpad in a geometry course. *International Journal of Mathematical Education in Science and Technology*, *51*(2), 183–207. https://doi.org/10.1080/0020739X.2019.1650302

Zulkardi, Meryansumayeka, Putri, R. I. I., Alwi, Z., Nusantara, D. S., Ambarita, S. M., Maharani, Y., & Puspitasari, L. (2020). How students work with pisa-like mathematical tasks using covid-19 context. *Journal on Mathematics Education*, *11*(3), 405–416. https://doi.org/10.22342/jme.11.3.12915.405-416

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v5i4.4442 Volume 5, No 4, October - December 2025, pp. 1788 – 1804

Author Biographies

	**Suci Indah Pratiwi** was born in Palembang on June 28, 1996. She is a student in the Department of Mathematics Education, Faculty of Teacher Training and Education, Universitas Sriwijaya. She is currently conducting research on Android-based PISA-type questions in the Ramadan context. Email: indahsuci806@gmail.com
	**Ratu Ilma Indra Putri** is a professor of mathematics education at Sriwijaya University. She began her academic career at the university in 1994. Her scholarly work has made substantial contributions to the fields of formative assessment, lesson study, literacy, and mathematics teaching methodologies. She has authored several educational books, including Research Methodology, History of Indonesian Realistic Mathematics Education (PMRI), and Assessment of Mathematics Education. Since 2016, she has also played a key role in institutional policy development within the Faculty of Teacher Training and Education at Universitas Sriwijaya, particularly in matters related to curriculum development, quality assurance units, and academic handbooks. She can be contacted via email at ratu.ilma@yahoo.com
	**Somakim** was born in Palembang on April 6, 1963. He is a faculty member at Universitas Sriwijaya. He completed his undergraduate studies in Mathematics Education at Universitas Sriwijaya in 1990, earned a master's degree in Mathematics Education from IKIP Surabaya in 1998, and obtained a doctoral degree in Mathematics Education from Universitas Pendidikan Indonesia (UPI), Bandung, in 2010. Email: somakim@unsri.ac.id