Jurnal Elemen, 11(1), 206-224, January 2025
https:/doi.org/10.29408/jel.v11i1.28013

e- ISSN: 2442 - 4226

Development of PISA-type questions and activities using election context to determine students' mathematical reasoning

Sylvenny Mirandah, Zulkardi [*], Ratu Ilma Indra Putri

Department of Mathematics Education, Sriwijaya University, South Sumatra, Indonesia

[*] Correspondence: zulkardi@unsri.ac.id

Abstract

The importance of developing PISA-type questions and learning activities is to familiarize students with these questions. This study employs a research design with development studies that include the stages of preliminary evaluation and formative evaluation. This research was conducted in response to the low mathematical reasoning skills of students in Indonesia, focusing on eighth-grade junior high school students. Qualitative findings were obtained from field data in the form of interviews, photos, and videos of the activities. The results of this study produced six units of activity questions and three units of evaluation questions on the theme of elections, which are valid and practical for enhancing mathematical reasoning abilities of eighth-grade students. The average score of students for Activity 1, Activity 2, and evaluation questions reached 53.45, indicating the potential effect of PISA-type questions and activities in the context of uncertainty and data with the theme of elections on students' mathematical reasoning skills, which are categorized as adequate. The reasoning indicator that appeared most frequently was the ability to make a conjecture, while the ability to manipulate mathematics was rarely observed. Overall, PISA-type questions and activities in an election context can be used to strengthen students' mathematical reasoning abilities.

Keywords: design research; election; mathematical reasoning ability; PISA-type question; uncertainty and data

How to cite: Mirandah, S., Zulkardi., & Putri, R. I. I. (2025). Development of PISA-type questions and activities using election context to determine students' mathematical reasoning. *Jurnal Elemen, 11*(1), 206-224. https://doi.org/10.29408/jel.v11i1.28013

Received: 31 October 2024 | Revised: 16 December 2024
Accepted: 5 January 2025 | Published: 1 February 2025

Introduction

Mathematical literacy has become increasingly important today. The ministry of education and culture launched the school literacy movement in 2021 to shape students' as lifelong learners. This was followed by the development of the Merdeka Curriculum, which emphasizes literacy in teaching and learning activities. Mathematical literacy refers to an individual's ability to reason mathematically in formulating, using, and interpreting mathematics to solve real-life problems, covering concepts, procedures, facts, and tools for explaining, describing, and predicting phenomena (OECD, 2018, 2019). Mathematical literacy is also known as numeracy (Kemendikbud, 2021). This skill is essential in daily life to understand the usefulness of mathematics and adapt to dynamic societal changes (Putra & Vebian, 2019).

PISA, as an international program, assesses the mathematics, reading literacy, and science abilities of 15-year-old students' every three years. The number of PISA participants has increased from 41 countries in 2000 to 81 countries in 2022 (OECD, 2022). Mathematical assessment was the main focus of PISA 2022, with Indonesia scoring 366, ranking 70-th out of 81 countries. This result indicates the low level of mathematical literacy among Indonesian students' (Fitriyani & Mastur, 2017).

The low achievement of Indonesian students in PISA, particularly in the mathematics domain, is attributed to their limited mathematical reasoning abilities and lack of practice with PISA-type questions in learning (Vebrian et al., 2021; Maharani et al., 2019). Moreover, textbooks do not adequately support the development of problem-solving skills in real-world contexts, such as PISA questions (Munayati et al., 2015; Dewi et al., 2017). Therefore, familiarizing students with PISA-type questions through learning activities is essential (Maharani et al., 2019).

The Indonesian Realistic Mathematics Education approach, adapted from Realistic Mathematics Education (RME), plays a key role in enhancing students' mathematical reasoning abilities. Indonesian Realistic Mathematics Education starts with real-life contexts, offering meaningful and enjoyable learning that trains students to think critically and express their ideas (Purba, et al., 2022). In PMRI, learning begins with sharing tasks that contain progressive questions and jumping tasks with higher difficulty levels (Nurazizah & Zulkardi, 2022). PMRI also connects real-life problems with formal mathematics to help students understand and apply mathematical concepts in daily life (Mubharokh et al., 2022).

In 21st-century learning, students' ability to collaborate is crucial (Mardhiyah et al., 2021). Teachers need to design context-based questions relevant to students' lives, in line with the contextual nature of PISA questions (OECD, 2018). Learning with local contexts, such as regional culture, has been used to develop PISA questions, such as the context of COVID-19 distribution (Saputri, 2020), the culture of Bangka Belitung (Putra & Vebrian, 2019), and Palembang’s jumputan cloth (Nabila, 2024).

The election context can also be used to develop PISA-type questions, helping students understand the importance of mathematics in political decision-making (Rahmawati, 2020). Through concepts such as the parliamentary threshold, Hare quota method, and Sainte-Laguë method, students not only learn mathematics but also understand the democratic system (Fauzi, 2020). This aligns with the goal of PISA mathematical literacy, which is to prepare students to use mathematics to solve real-world problems (OECD, 2018).

This study aims to develop PISA-type questions with an election context to strengthen the mathematical reasoning abilities of junior high school 54 *Palembang* students. It is hoped that this solution will provide an alternative to improve students' abilities, as they have not been accustomed to working with PISA-type questions.

Methods

This study is categorized as development research, aimed at developing PISA-type questions with an election context using the PISA 2022 framework. The primary objective of this research is to produce PISA-type questions with an election context that can strengthen the mathematical reasoning abilities of junior high school students' 54 *Palembang*. The focus of the study lies in the development of PISA-type questions in the content domain of uncertainty and data, applying the Indonesian Realistic Mathematics Education (PMRI) approach with an election-based context. The questions were designed to be valid, practical, and effective, consisting of three types of activities: sharing tasks, jumping tasks, and test questions. The subjects of this study were eight-grade students of junior high school 54 *Palembang* in the 2024/2025 academic year, with varying (heterogeneous) levels of ability. The research was conducted offline to ensure direct interaction between students' and researchers during the development and testing of the questions.

Making a conjecture, mathematical manipulation, and drawing conclusions. The development procedure for the learning video in this research includes two main phases (Bakker, 2018). The preliminary stage is further divided into three sub-phases: preparation, analysis, and design. During the preparation phase, the researcher gathers necessary resources and defines the objectives of the learning tools. In the analysis phase, the researcher examines existing materials and student needs to inform the design process. The design phase focuses on creating drafts of learning materials, including question grids and activity sheets tailored to the students' contexts. The formative evaluation stage involves several steps aimed at refining the developed materials. This includes self-evaluation, where the researcher reflects on the effectiveness of the materials, followed by an expert review, where feedback is sought from educational professionals. The one-to-one testing phase allows for direct interaction with individual students to identify challenges, while the small group testing phase involves small groups of students to gauge collaborative problem-solving. Finally, a field test is conducted in a classroom setting to assess the practical application and effectiveness of the materials (Zulkardi, 2002). This systematic approach ensures that the developed PISA-type questions and activities are valid, practical, and beneficial for enhancing students' mathematical reasoning abilities.

Observations were conducted both directly and through video recordings during learning sessions that utilized students' worksheets learning tools featuring PISA-type questions and activities within the election context. To assess students' mathematical reasoning abilities, a test consisting of three descriptive questions was administered. These qualitative data from interviews helped to elucidate the challenges students faced and their understanding of the material, providing a deeper perspective on their mathematical reasoning abilities. Overall, the combination of observations, tests, and interviews allowed for a comprehensive analysis of student performance and engagement, enabling the researchers to assess the effectiveness of the PISA-type questions and the learning activities designed within the study.

Observation data were analyzed descriptively to detail student activities during learning. This analysis focused on capturing students' expressions when they encountered difficulties and their ability to convey newly acquired knowledge.

Interview data were also subjected to descriptive analysis. The researchers reviewed the recorded interviews and transcribed only the relevant portions of the conversations, which allowed for the identification of common themes and insights related to students' understanding and problem-solving approaches. The test data underwent a structured descriptive analysis through the following steps: (1) Creating an answer key and scoring rubric: an answer key was developed to provide a standard for evaluating student responses, and a scoring rubric was established to ensure consistency in assessment. (2) Checking students' answers: students' responses were compared against the answer key to determine correctness and completeness. (3) Assigning scores: scores were assigned based on the established scoring guidelines, which categorized responses according to their accuracy and completeness. Provides the scoring guidelines used in this study, which detail the criteria for each score category.

Presents the scoring indicators associated with each score used to evaluate students' mathematical reasoning abilities. These indicators help in assessing the quality of students' responses to the PISA-type questions and activities. The scores obtained from students' answers are subsequently converted into numerical scores, allowing for a standardized assessment of their performance. These categories not only provide insight into students' mathematical reasoning capabilities but also facilitate the identification of areas for further instruction and support.

Categorizes students' scores categories: very good, good, sufficient, less, and very less. Each category represents a range of scores that reflect the level of students' mathematical reasoning abilities. The frequency of scores within each category will be calculated to understand how many students' fall into each classification. This statistical breakdown helps in analyzing the overall performance of the class. To determine the average score, the formula for averaging grouped data will be utilized. The resulting average score will then be re-categorized according to the classifications outlined, providing a clear indication of the overall mathematical reasoning ability of the students in the study. This process ensures that the average score is meaningful and reflects the collective performance in alignment with the defined categories.

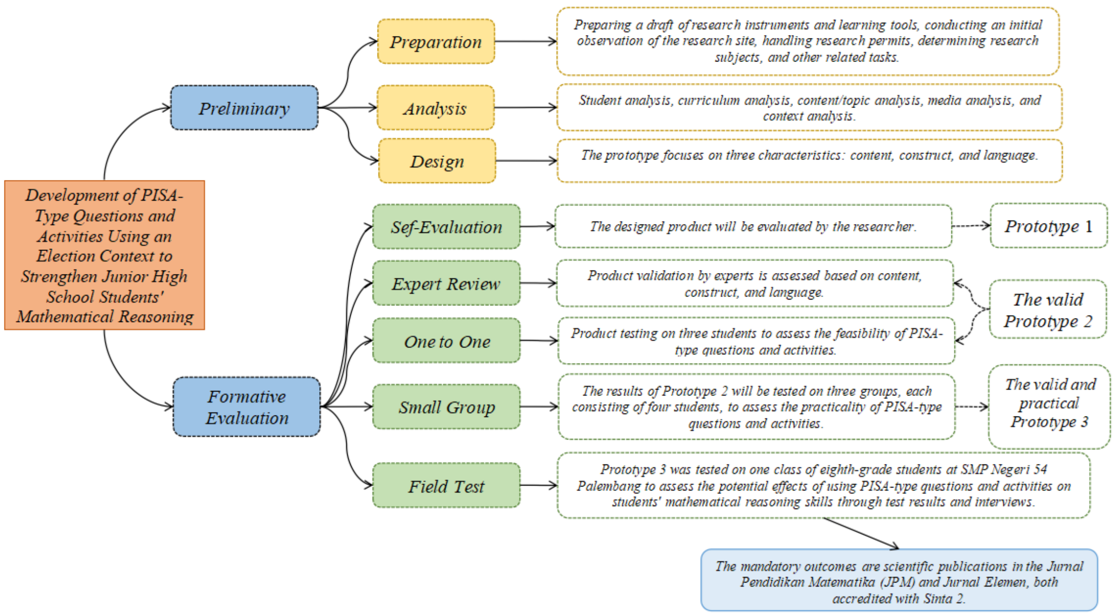

Figure 1. Research flowchart

Results

The findings of this study are based on the stages of question and activity development described earlier. The research aimed to develop PISA-type questions in the uncertainty and data content domain with an election context. The questions produced include two main activities and one set of evaluation questions. Activity 1 consists of three units: the *DPR-R*I unit in *Bukit Kecil* District (1 question), the *DPR-RI* unit in 5 Districts (3 questions), and the invalid ballot unit in 2 Districts (3 questions). Activity 2 also comprises three units: the Parliamentary Threshold unit (1 question), the Hare Quota Method unit (1 question), and the Sainte-Laguë Method unit (1 question). Meanwhile, the evaluation questions consist of three units: the *DPD* unit in *Alang-Alang Lebar* District (4 questions), the *DPD* unit in *Bukit Kecil* District (3 questions), and the *DPRD*-Province unit in South Sumatera 1 (3 questions). The development stages include the preparation stage (preliminary) and the formative evaluation, which consists of self-evaluation, expert reviews, one-to-one evaluation, and field testing.

Preliminary stage

Stage 1: Preparation

The research needs to prepare the following items: (1) Observation sheets, question grids, test cards, mathematical reasoning test questions, rubrics for evaluating test questions, and interview guidelines. (2) Arrangements for conducting interviews. (3) Drafts of learning materials. (4) Preliminary observations at the research site, which involve coordinating with school officials especially mathematics teachers to discuss the research schedule and subjects. (5) Management of research documentation and any additional required preparations.

Stage 2: Analysis

The in the student analysis stage, the researcher conducted identification and analysis of the students' who served as the subjects of the study. The initial step was to identify the target school, junior high school 54 *Palembang*, and select eighth-grade students as research subjects. The researcher interviewed the mathematics teacher, Hj. Etty Susanty, S.Pd., to gather information about the eighth-grade students', including categorizing their abilities into three levels: low, medium, and high.

The researcher also explained to the teacher the series of research activities to be conducted at the school, including discussions about selecting students for the one-to-one, small group, and field test stages. For the one-to-one stage, the researcher required three students with different ability levels (low, medium, and high) who were not part of the main research subjects. For the small group stage, the researcher needed twelve students' consisting of four students with low abilities, four with medium abilities, and four with high abilities.

In the final stage, the field test, the research subjects were the students of eighth one-grade at junior high school 54 *Palembang*. This class consisted of 35 students aged 13–15 years with diverse abilities. Based on the analysis and discussions, class eighth two-grade students were used for the one-to-one and small group stages, while eighth one-grade students were the subjects for the field test stage.

In the curriculum analysis, the researcher selected mathematics teaching materials aligned with the *Kurikulum Merdeka* implemented at junior high school 54 *Palembang*, where the study was conducted. This curriculum is applied to eighth-grade students', and the material on the uncertainty and data content, related to statistics, is taught at this level.

The researcher analyzed PISA questions from previous years and connected them to the PISA 2022 framework. This analysis aimed to understand the general characteristics of PISA questions, including their context and content. Additionally, the researcher identified knowledge related to process skills and levels of mathematical reasoning abilities assessed in PISA questions. The results of this analysis formed the basis for developing PISA-type questions and activities in the election context, focusing on the uncertainty and data content.

Stage 3: Design

The researcher designed learning tools, including test blueprints, question cards, scoring rubrics, and lesson plans. Additionally, the researcher developed PISA-type questions and activities in the election context, aligned with the PISA 2022 framework. During the design process, the researcher modified PISA questions from previous years based on knowledge and insights gathered during the analysis phase. This stage resulted in three units of PISA-type questions for Activity 1, three units for Activity 2, and three units of evaluation questions, all utilizing the election context with uncertainty and data content. Which can be seen in the following link: https://drive.google.com/drive/folders/1vWEVucfFQGdUKK-FFE4t0vr-O8Dw1e5k?usp=sharing

Formative evaluation stage

Stage 1: Self-evaluation

At after completing the question and activity design, the self-evaluation stage was conducted, during which the researcher personally reviewed and evaluated the developed questions and activities. Key aspects considered included content, structure, and language. At this stage, the researcher corrected errors such as typos, inappropriate word usage, or deficiencies in word choice.

The researcher also decided to add question units to Activity 1 and Activity 2, each consisting of three units, and to refine several questions from previous units. The results of the evaluation and subsequent revisions were as follows. Activity 1: Initially, there were three similar and relatively easy problems. Following the evaluation, the researcher diversified the questions by varying the level of difficulty to better enhance students' mathematical reasoning ability. Activity 2: Originally, it included only one problem focusing on the concepts of mean, median, and mode. However, since PISA-type questions typically do not involve such problems, the researcher replaced them with three new problems related to election calculations, namely Parliamentary Threshold, Hare Quota Method, and Sainte-Laguë Method, which are topics unfamiliar to students. Evaluation Questions: initially, the three problems were inadequate for measuring students' mathematical reasoning abilities. After reevaluation, these questions were modified to be more specific, focusing on legislative election calculations.

This stage resulted in the creation of PISA-type questions and activities within the context of elections under the uncertainty and data content, comprising the following. Activity 1: Three units of questions, including *DPR-RI* in *Bukit Kecil* District (1 question), *DPR-RI* in 5 District (3 questions), and invalid votes in 2 District (3 questions). Activity 2: Three units of questions, including Parliamentary Threshold (1 question), Hare Quota Method (1 question), and Sainte-Laguë Method (1 question). Evaluation Questions: Three units of questions, including *DPD* in *Alang-alang Lebar* District (4 questions), *DPD* in *Bukit Kecil* District (3 questions), and *DPRD-Provinsi* in South Sumatera 1 (3 questions). These revisions resulted in a set of questions and activities referred to as Prototype 1. Subsequently, the questions and activities in Prototype 1 were validated through expert reviews and tested during the one-to-one stage.

Stage 2: Expert review

At this stage, the validation of the questions was conducted by the thesis advisors, Prof. Dr. Zulkardi, M.I. Kom., M.Sc., and Prof. Dr. Ratu Ilma Indra Putri, M.Si. The validation assessed the questions based on three main criteria: content, construct, and language. Additionally, the researcher involved several experienced experts to validate the questions. These experts included Dr. Duano Sapta Nusantara, S.Pd., a lecturer at Jambi University; Dr. Laela Sagita, S.Pd., M.Sc., a lecturer at PGRI Yogyakarta University; and Hj. Etty Susanty, S.Pd., a mathematics teacher at junior high school 54 *Palembang*. This validation process aimed to ensure that the PISA-type questions developed met quality standards in terms of content, structure, and language use.

Table 1. Validation results

Dr. Duano Sapta Nusantara, S.Pd.	Dr. Laela Sagita, S.Pd., M.Sc.	Hj. Etty Susanty, S.Pd.
➢ Unit 2: Questions 1-3 are of equal difficulty; they should be structured hierarchically to vary the levels of difficulty. ➢ The presentation should guide students' more effectively by including visual aids such as pie charts or bar charts. ➢ Questions in PISA-type problems should not involve Mean, Median, and Mode, as these concepts are not commonly assessed in PISA. ➢ Unit 7: The phrasing of the questions should be revised to improve clarity and alignment with the framework. ➢ Questions should follow a hierarchical structure. In some cases, such as in Unit 8, Question 2 depends on the answer to Question 1, which may hinder students' progress if the first question is unanswered. ➢ In Unit 8, Questions 1 and 2 appear too similar and should be differentiated to avoid redundancy.	➢ The problems presented in the Student Worksheets align well with the PISA 2022 framework for the mathematical literacy domain, specifically in the content area of uncertainty and data. ➢ However, some of the scaffolding provided is overly open-ended, which makes it less effective in addressing the indicators of mathematical reasoning abilities. ➢ The evaluation questions are appropriately designed and conform to the PISA 2022 framework for the mathematical literacy domain, particularly for the content area of uncertainty and data.	➢ The topic of legislative calculations has never been taught before in school; it would be better to start with a smaller scope first. ➢ For Unit 7, the wording should be revised as it may cause misinterpretation by students.
Improve according to comments and suggestions		

Based on the results of the expert reviews stage for Prototype 1, it was found that three units of questions in Activity 1, three units of questions in Activity 2, and three units of evaluation questions were assessed by the experts. Several comments and suggestions from the experts covered various aspects, ranging from language improvements, restructuring the questions to be more progressive, to adjusting the context of the questions to better align with the goal of developing PISA-type questions in the context of uncertainty and data.

These validation results provide the researcher with the opportunity to make improvements and refine the questions and activities developed in Prototype 1. With the feedback received, the researcher can make further revisions to ensure that the questions and activities meet quality and relevance standards in line with the PISA 2022 framework, and that they are more effective in enhancing students' mathematical reasoning skills.

Stage 3: One-to-One

The validity of the PISA-type questions and activities with an election context was also tested through individual trials during the one-to-one stage. At this stage, Prototype 1 was tested on three eight two-grade students from junior high school 54 *Palembang* with varying abilities high, medium, and low. The students' involved in this trial were three students' the trial was conducted offline in the classroom on November 18, 2024.

The one-to-one process was conducted alternately. Before the trial began, the researcher provided questions and activities in the form of students' worksheets. Students were asked to observe and solve the questions and activities in Prototype 1, while the researcher observed and interacted with the students. When students' encountered difficulties in solving the problems, the researcher offered assistance to understand the students' thinking processes, from comprehension to solution. Additionally, students were given the opportunity to provide comments and suggestions on the questions and activities they had completed as input for the evaluation and improvement of Prototype 1.

Based on the analysis of validation from the expert reviews stage and the one-to-one trial, several improvements were identified for Prototype 1. The researcher found that while three students understood the intent of the Sainte-Laguë Method presented in the problem, there were still minor errors that needed to be corrected. The following are the improvements made based on these findings:

1. Unit 2: The questions in items 1–3 was deemed to have an equivalent level of difficulty. The questions should be designed to progress incrementally to enhance students' thinking skills step by step.
2. Data Visualization: To help students better understand the context of the questions, the data should be presented using pie charts or bar graphs for more intuitive representation.
3. PISA Question Content: PISA questions do not include concepts like mean, median, and mode. Therefore, questions containing these concepts must be revised to align with the format and characteristics of PISA questions.
4. Question Wording in Unit 7: The wording of the questions needs to be revised to make them clearer and more relevant to the election context.
5. Progression of Questions: Questions should be structured progressively, especially when subsequent questions depend on the answers to previous ones. For example, question 2 cannot be answered if the student fails to answer question 1.
6. Unit 8 Questions 1 and 2: These two questions were found to be too similar. One of the questions should be replaced to provide variety and enhance students' problem-solving skills.

These improvements aim to enhance the quality of the PISA-type questions and activities developed, ensuring alignment with the PISA 2022 framework and effectively measuring students' mathematical reasoning abilities. Which can be seen in the following link: https://drive.google.com/drive/folders/11S3E5d3PVWjGyPcczaHI1u7GgSRBUvNL?usp=sharing

Stage 4: Small group

During the small group stage, the researcher involved twelve students with varying abilities (high, medium, and low), divided into three groups. This stage was conducted on November 21, 2024, at junior high school 54 *Palembang*, with the participating students' being twelve students. The activity was carried out over two sessions: the first session focused on learning activities using PISA-type questions, while the second session involved evaluation questions tested on the students.

In the first session, the researcher initiated the lesson by engaging students in a discussion about their knowledge of the election context. The researcher connected this to common issues during elections, such as the use of table diagrams, pie charts, and bar charts, as well as methods for calculating legislative votes, such as the Parliamentary Threshold, Hare Quota Method, and Sainte-Laguë Method. The learning activities used data analysis to solve the presented problems.

The researcher then asked questions about prerequisite materials previously studied by the students', such as data analysis and converting pie charts into table diagrams, to assess their understanding. The results showed that some students recalled the material, while others appeared to have forgotten. Subsequently, the researcher distributed activity sheets containing questions for Activities 1 and 2, where students worked on the problems individually before discussing them in their assigned groups. The researcher and observers monitored student interactions during the discussion, where they collaborated to solve the problems. After 50 minutes, group representatives were asked to present their discussion results to the class.

In the second session, the researcher administered an evaluation test to each student individually. Before the test began, the researcher conducted a brief review to remind students of the prerequisite materials they had previously learned. students were given 80 minutes to complete the evaluation questions. For this stage, the researcher applied the Problem-Based Learning (PBL) model. The steps included: (1) Orientation of students to the problem: The researcher presented problems in the activity sheets and asked students to observe and understand the issues. (2) Organizing students for learning: students were divided into three groups (each consisting of four students with high, medium, and low abilities). Each group was asked to discuss and find solutions to the given problems and seek clarification if they encountered difficulties. (3) Guiding individuals and groups: The researcher guided students' during discussions to solve the problems, providing assistance when students were confused or required clarification. (4) Developing and presenting the work: Each student documented their group's discussion results, and group representatives presented the outcomes to the class. (5) Analyzing and evaluating the problem-solving process: After the presentations, students were asked to analyze the discussion results of other groups and provide feedback if there were differences. Finally, students summarized the lessons learned that day.

Based on the responses, observations, and interviews with students' during the small group stage, the researcher made improvements to Activity 1, Activity 2, and the evaluation questions in Prototype 2. These revisions aimed to produce a more valid and practical Prototype 3. Which can be seen in the following link: https://drive.google.com/drive/folders/1rLIBkX8ur2hoKMJEYpHVYnFOimip_Dnz?usp=sharing

Stage 5: Field test

At the field test stage, the questions and activities in Prototype 3, which had been revised based on evaluations from the one-to-one, expert reviews, and small group stages, were directly tested on the students' who served as the research subjects. The selected research subjects consisted of 35 students from one class, eighth one-grade at junior high school 54 *Palembang*, with low, medium, and high abilities. This stage was conducted over three sessions: two sessions for learning and one session for testing the evaluation questions. During this stage, the researcher collaborated with the class teacher, Hj. Etty Susanty, S.Pd., as the model teacher for implementing the ongoing field test stage.

In the learning process during the first and second sessions, the model teacher began by introducing the material to be studied, which included analyzing data, converting pie charts into bar charts, and calculations in the context of elections (Parliamentary Threshold, Hare Quota Method, and Sainte-Laguë Method). In addition, the model teacher also informed the students of the learning objectives for the day. The teacher provided information about elections, which served as the context for the day's learning activities. The model teacher also reviewed the prerequisite materials needed to solve the problems. Following this, the teacher distributed Activity Sheets 1 and 2 to each student, each containing three units.

In the first session, students observed, understood, and solved the questions in Activity 1 individually at first, then discussed their answers within their respective groups. Afterward, group representatives presented their answers, and other groups were given the opportunity to provide arguments about the answers presented by their peers.

In the second session, students observed, understood, and solved the questions in Activity 2 individually, though they were allowed to seek assistance from their group members. After completing Activity 2, the model teacher asked group representatives to present their answers, while the other students' provided reasons or responses.

In the third session, an evaluation in the form of a test was conducted for each student, consisting of three units of questions. Before the test began, the model teacher gave students' an overview of the material needed to solve the questions. students were given 80 minutes to complete the test, during which they worked independently without discussing with other students. Which can be seen in the following link: https://drive.google.com/drive/folders/1eEs2DCanVxgWymrGSaaqKVTR6tf-Ti9D?usp=sharing

a. Activity 1

Table 2. Indicators appearing in activity 1

Indicators	Total students' who meet the criteria							Total
	Unit 1	Unit 2			Unit 3			
	1	1	2	3	1	2	3	
Make a conjecture	30	31	23	17	15	10	21	147
Mathematical manipulation	31	31	22	20	14	10	21	149
Draw a conclusion	23	35	32	19	15	7	21	152

In Table 2, activity 1 shows that indicator make a conjecture total 147, indicator mathematical manipulation total 149, and indicator draw a conclusion total 152. The most frequently appearing indicator is the indicator of draw a conclusion, while the least frequently appearing indicator is the indicator of make a conjecture.

b. Activity 2

Table 3. Indicators appearing in activity 2

Indicators	Total students' who meet the criteria			Total
	Unit 4	Unit 5	Unit 6	
	1	1	1	
Make a conjecture	33	17	9	59
Mathematical manipulation	29	7	5	41
Draw a conclusion	32	13	9	54

In Table 3, activity 2 shows that indicator make a conjecture total 59, indicator mathematical manipulation total 41, and indicator draw a conclusion total 54. The most frequently appearing indicator is the indicator of make a conjecture, while the least frequently appearing indicator is the indicator of mathematical manipulation.

c. Evaluation questions

Table 4. Indicators appearing in evaluation questions

Indicators	Total students' who meet the criteria										Total
	Unit 7				Unit 8			Unit 9			
	1	2	3	4	1	2	3	1	2	3	
Make a conjecture	31	24	33	33	10	30	31	25	27	32	276
Mathematical manipulation	31	23	33	34	32	33	4	4	11	25	230
Draw a conclusion	34	33	34	34	3	7	6	31	4	29	215

In Table 4, evaluation questions shows that indicator make a conjecture total 276, indicator mathematical manipulation total 230, and indicator draw a conclusion total 215. The most frequently appearing indicator is the indicator of make a conjecture, while the least frequently appearing indicator is the indicator of draw a conclusion. Next, the results of the analysis are shown in Table 5.

Table 5. Analysis of students' mathematical reasoning ability

Score	Unit 1	Unit 2			Unit 3			Unit 4	Unit 5	Unit 6	Total
	1	1	2	3	1	2	3	1	1	1	
81-100	11	27	11	4	0	0	0	22	3	4	82
61-80	8	4	10	4	8	2	21	7	2	0	66
41-60	11	0	2	12	6	6	0	2	8	5	52
21-40	5	4	10	8	8	9	0	3	6	1	54
0-20	0	0	2	7	13	18	14	1	16	25	96
Score	**Unit 7**				**Unit 8**			**Unit 9**			**Total**
	1	**2**	**3**	**4**	**1**	**2**	**3**	**1**	**2**	**3**	
81-100	26	18	27	28	0	0	3	4	2	2	110
61-80	5	5	6	5	3	5	0	0	2	18	49
41-60	0	0	0	0	4	25	4	18	6	5	62
21-40	3	11	1	2	28	5	24	12	18	7	111
0-20	1	1	1	0	0	0	4	1	7	3	18

Table 5 show that the highest number of students scored within the range of 81-100, with 192 students' achieving this range. Next, the average mathematical reasoning ability of students on the topic of ratios, as obtained, is presented in Table 6.

Table 6. Average mathematical reasoning ability of students

Score	Total	x_i	Total × x_i	Average
81-100	192	90.5	17,376	53.45
61-80	115	70.5	8,107.5	
41-60	114	50.5	5,757	
21-40	165	30.5	5,032.5	
0-20	114	10	1,140	
Total	**700**		**37,413**	

Based on Table 6, it shows that after the implementation of learning using the development of PISA-type questions on the content of uncertainty and data with an election context through the PMRI approach an PBL model, the mathematical reasoning ability of the eight-grade students at junior high school 54 *Palembang* is considered sufficient, with an average score of 53.45.

Discussion

Characteristics of valid and practical PISA-type problems and uncertainty and data content activities with election contexts

In this study, the process of developing questions and activities went through two stages: the preliminary and formative evaluation stages. Feedback and suggestions obtained at each evaluation stage were used by the researcher as material to improve the Prototype, ultimately producing PISA-type questions and activities on the content of uncertainty and data in the context of elections that are valid and practical. These also demonstrated potential effects on students' mathematical reasoning abilities, particularly for eight-grade students at junior high school 54 *Palembang*.

The researcher developed questions and activities divided into two parts. Activity 1 included three units: the *DPR-RI* in *Bukit Kecil* District (1 question), the *DPR-RI* in 5 districts (3 questions), and invalid votes in 2 districts (3 questions). Activity 2 also consisted of three units: the Parliamentary Threshold (1 question), the Here Quota Method (1 question), and the Sainte-Laguë Method (1 question). Additionally, there were three units for evaluation questions: *DPD* in *Alang-Alang Lebar* District (4 questions), *DPD* in *Bukit Kecil* District (3 questions), and the *DPRD*-Provincial in South Sumatra 1 (3 questions).

During the preliminary evaluation stage, the researcher conducted an individual evaluation of the developed questions and activities, referred to as the self-evaluation stage. From this process, improvements were made to produce Prototype 1. Furthermore, Prototype 1 was advanced to the expert reviews and one-to-one stages, aimed at examining the validity of the developed questions and activities. Improvements from these stages resulted in Prototype 2.

Prototype 2 was deemed valid because of revisions based on the outcomes of the expert reviews and the one-to-one stage, assessed in terms of content, construct, and language. The developed questions and activities aligned with the characteristics of PISA questions and the material in the *Kurikulum Merdeka*. Specifically, the content and context focused on uncertainty and data in the election context, integrated into the societal context based on the PISA 2022 framework.

Dr. Duano Sapta Nusantara, S.Pd., from Universitas Jambi, Dr. Laela Sagita, S.Pd., M.Sc., from Universitas PGRI Yogyakarta, and Hj. Etty Susanty, S.Pd., a mathematics teacher at junior high school 54 *Palembang*, served as validators. They stated that all the developed questions met the assessment criteria in terms of content. This was evident from the validation sheets provided to the validators, who consistently agreed during the panel review process. Thus, it was concluded that the content of the questions was valid.

Regarding construct validity, the questions and activities were developed based on the level of students' abilities, particularly eight-grade students. The problems presented were consistent with the characteristics of question levels as defined by the PISA 2022 framework. The PISA-type questions and activities also met the OECD criteria for PISA question levels.

The language evaluation was based on proper and correct use according to the Indonesian language standard. The sentences used were effective, straightforward, and did not lead to multiple interpretations. Experts found that the language used in the developed questions and activities met the language assessment criteria. However, some questions and activities, especially those in Unit 7 of the evaluation questions, needed revisions to ensure effective sentence structure if they were to be retained.

In the one-to-one stage, the researcher tested the developed questions and activities on three students with different abilities high, medium, and low. The results showed that the students could understand and solve the questions and activities, although their understanding of Unit 7 evaluation questions differed from the researcher's expectations. Therefore, the researcher decided to revise the questions based on feedback and suggestions from experts and student trials. These revisions made the questions and activities linguistically valid.

Based on the above description, it can be concluded that the PISA-type questions and activities on uncertainty and data in the context of elections were valid according to three criteria: content, construct, and language.

Producing a practical Prototype was achieved after obtaining a valid Prototype in terms of content, construct, and language. The developed questions were considered practical based on students' feedback and researchers' observations during the small group stage. Their practicality was demonstrated when students showed that the developed questions and activities could be used effectively in learning. Students could understand the questions well, and the activities aligned with their thought patterns. The context used was familiar to the students', the questions were easy to read, and students understood how to use tables and graphs to solve the questions and activities.

Additionally, during the small group stage, trials were conducted on 12 students from junior high school 54 *Palembang* with varying abilities. The learning process began with an introduction to explore and assess students' prior knowledge about the election context. This stage used the Problem-Based Learning (PBL) model, aimed at familiarizing students with solving PISA-type questions before facing evaluation questions in the final session.

The learning process followed the steps of the PBL model, which consists of five stages: (1) orienting students' to the problem, where the teacher transforms the problem into an activity to engage students' interest; (2) organizing students' for learning, where students' are divided into groups of 4–5 and allowed to ask questions about unclear problems; (3) guiding individual/group investigation, where students' first solve problems individually, then collaborate and discuss in groups while the teacher observes and assists when needed; (4) developing and presenting work results, where group representatives present their discussion results to the class; and (5) analyzing and evaluating the problem-solving process, where students' provide feedback on other groups' presentations, and the teacher corrects any errors in the discussion.

This aligns with Dutch (Amir, 2009), who stated that PBL is a teaching method that challenges students to learn how to learn, work collaboratively to solve problems in groups, and use real-life problems to stimulate curiosity and analytical skills. Afterward, the researcher revised Prototype 2 based on observations during the small group stage to reduce student errors in interpreting questions, making learning more efficient. The revisions to Prototype 2 resulted in updates to the questions and activities, which were then used in the field test stage. These included Activity 1 (sharing tasks) with three problems, Activity 2 (jumping tasks) with three problems, and three units of evaluation questions. The improvements from the small group stage produced Prototype 3, which was subsequently tested during the field test stage.

Potential effects of PISA-type problems and uncertainty and data content activities with election contexts

The PISA-type questions and activities validated and refined in Prototype 3 were tested on students in the final stage, namely the field test phase. This phase involved the research subjects to observe the potential effects of the developed PISA-type questions and activities within the context of uncertainty and data on students' mathematical reasoning abilities. The participants in this stage were eighth-grade students from junior high school 54 *Palembang*. The indicators of students' mathematical reasoning abilities observed in the findings are described as follows:

Make a conjecture

This indicator was observed when students were able to articulate information obtained from the given questions. This aligns with Rahmawati & Putri (2022), who stated that students demonstrate the ability to propose hypotheses when they can derive relevant information from the problem.

Mathematical manipulation

Students were able to solve problems by translating the questions from textual form into mathematical representations. This aligns with the research of Khoirunnisa & Putri (2022), which demonstrated that students could transform problems into mathematical statements.

Draw a conclusion

Students' who successfully made appropriate and logical conclusions based on the given questions demonstrated the third indicator. This aligns with Nurazizah & Zulkardi (2022), who noted that students could draw logical conclusions that align with the problem's context.

Based on the conducted research, it can be concluded that the PISA-type questions and activities focusing on uncertainty and data in the context of elections have a potential effect on enhancing the mathematical reasoning abilities of eighth-grade students at junior high school 54 *Palembang*. Although the average performance was 53.45, there are still students' who have not fully exhibited all indicators of mathematical reasoning abilities.

Conclusion

This study developed PISA-type questions and activities within the context of elections, designed to enhance students' mathematical reasoning skills. The questions are divided into two main activities: Activity 1, which involves three units focusing on *DPR-RI* and invalid ballots in various districts, and Activity 2, which includes units on Parliamentary Threshold, the Quota Method (Here), and the Sainte-Laguë Method. Additionally, there are evaluation questions that assess students' abilities in the election context through various questions designed based on three levels: knowledge and understanding (level 1), application (level 2), and reasoning (level 3).

The developed questions and activities are both valid and practical. These questions integrate mathematical content from the *Kurikulum Merdeka*, particularly focusing on data analysis, and employ the election context as a new topic for students'. The language used in the questions is standardized and unambiguous, ensuring clarity and accuracy. Furthermore, these questions effectively measure the process competence of students' mathematical reasoning skills in alignment with the PISA 2022 framework. Students demonstrated the ability to propose hypotheses, perform mathematical manipulations, and draw conclusions based on their understanding of the election context. However, although the average student score reached 53.45 indicating a potential effect on improving mathematical reasoning the most frequently observed indicator was the ability to make a conjecture, while the indicator for mathematical manipulation appeared less frequently. This suggests that, while the questions and activities were fairly effective, there is room for improvement to optimize students' ability to perform mathematical manipulations in more complex contexts.

Acknowledgment

The authors would like to express appreciation to the mathematics teachers, principals, and administrative staff at junior high school 54 *Palembang* for their significant support throughout the research activities.

Conflicts of Interest

The authors declare that there are no conflicts of interest associated with the publication of this manuscript.

Funding Statement

The authors would like to express our sincere gratitude to Universitas Sriwijaya for funding this research with profession grant number 0016/UN9/SK.LP2M.PT/2024.

Author Contributions

Sylvenny Mirandah: Developing PISA-type question, collecting and analyzing data; **Zulkardi**: Advisor and director in developing PISA-type question; **Ratu Ilma Indra Putri**: Advisor and director in developing PISA-type question.

References

Achera, L.J, Belecina, R.R dan Garvida, M.D. (2015). The effect of group guided discovery approach on the performance of students in geometry. *International Journal of Multidiciplinary Research and Modern Eductaion (IJMRME)*, *1*(2), 331-342. Diakses dari http://rdmodernresearch.org/

Agusta, E. S. (2021). Peningkatan kemampuan pemecahan masalah matematis melalui penggunaan konteks dan model dalam PMRI [Increasing mathematical problem-solving abilities through the use of context and models in PMRI]. *ALGORITMA Journal of Mathematics Education (AJME)*, *3*(2), 144-168.

Annajmi (2019). Pengaruh penggunaan lembar aktivitas siswa berbasis metode penemuan terbimbing terhadap peningkatan kemampuan representasi matematis siswa [The effect of using student activity sheets based on the guided discovery method on increasing students' mathematical representation abilities]. *Mosharafa: Jurnal Pendidikan Matematika*, *8*(1). https://doi.org/10.31980/mosharafa.v8i1.410

Baka, N.A., Laksana, D.N.L. & Dhiu, K.D. (2019). Konten dan konteks budaya lokal ngada sebagai bahan ajar tematik di sekolah dasar [Local cultural content and context do not exist as thematic teaching materials in elementary schools]. *Journal of Education Technology*, *2*(2), 46-55. https://doi.org/10.23887/jet.v2i2.16181

Charmila, N., Zulkardi., & Darmawijoyo. (2016). Pengembangan soal matematika model PISA menggunakan konteks Jambi [Development of PISA model mathematics questions using the Jambi context]. *Jurnal Penelitian dan Evaluasi Pendidikan*, *20*(2), 198-207. Diakses dari https://doi.org/10.21831/pep.v20i2.7444

Dewi, A. I. C., Zulkardi, & Yusuf, M. (2017). Kesulitan siswa dalam menyelesaikan soal-soal PISA tahun 2012 level 4, 5 dan 6 di SMPN 1 Indralaya [Students' difficulties in solving 2012 PISA questions levels 4, 5 and 6 at SMPN 1 Indralaya]. *Jurnal Pendidikan Matematika*, *11*(2), 1-15. https://doi.org/10.22342/jpm.11.2.4643.1-15

Dewi, R., Putri, R. I. I., & Hartono, Y. (2018). Pengembangan multimedia interaktif berbasis PMRI materi jajargenjang [Development of interactive multimedia based on PMRI parallelogram material]. *Jurnal Matematika Kreatif-Inovatif*, *9*(1), 78-83. https://doi.org/10.15294/kreano.v9i1.14367

Edo, S. I., Tanghamap, K. & Tasik, W. F. (2015). Model pembelajaran penjumlahan dan pengurangan bilangan melalui pendekatan PMRI konteks permainan karet gelang [Model for learning addition and subtraction of numbers using the PMRI approach in the context of the rubber band game]. *Jurnal Pendidikan Matematika*, *9*(2), 1304-1329. https://doi.org/10.22342/jpm.9.2.2428.99%20-%20123

Fitriyani, Ika., Mastur, Zaenuri. (2017). Kemampuan literasi matematika siswa ditinjau dari kecerdasan emosional pada pembelajaran CPS berbantuan hands on activity [Students' mathematical literacy abilities are viewed from emotional intelligence in CPS learning assisted by hands on activities]. *Unnes Journal of Mathematics Education Research*, *6*(2), 139-147. https://journal.unnes.ac.id/sju/index.php/ujmer/article/view/20457

Gravemeijer, K. (2010). *Realistic mathematics education theory as a guideline for problem-centered, interactive mathematics education.*

Hidayah, S. R., & Siregar, N. (2023). Studi literatur analisis peningkatan kemampuan komunikasi matematis siswa dengan pendekatan pembelajaran matematika realistik [Literature study analysis of improving students' mathematical communication skills with a realistic mathematics learning approach]. *Jurnal Riset Rumpun Ilmu Pendidikan (JURRIPEN)*, *2*(1), 99-113.

Jannah, R. D., Putri, R. I. I., & Zulkardi. (2019). Soft tennis and volleyball contexts in asian games for PISA-like mathematics problems. *Journal on Mathematics Education*, *10*(1), 157-170. http://dx.doi.org/10.22342/jme.10.1.5248.157-170

Kemendikbud. (2021). *Modul literasi numerasi di sekolah dasar* [*Numeracy literacy module in elementary schools*]. Kemendikbud.

OECD. (2018). PISA 2021 *mathematics framework (draft).* OECD Publishing. https://www.oecd.org/pisa/pisaproducts/pisa-2021-mathematicsframeworkdraft.pdf

OECD. (2018). PISA 2022 *mathematics framework draft.* OECD Publishing. https://pisa2022maths.oecd.org/files/PISA%202022%20Mathematics%20Framework%20Draft.pdf

OECD. (2019). PISA 2018 *assessment and analytical framework.* OECD Publishing. https://www.oecd-ilibrary.org/education/pisa-2018-assessment-and-analytical-framework-b25efab8-en

OECD. (2022). PISA 2022 *results combined executive summaries volume I, II & III.* OECD Publishing. https://www.oecd.org/pisa/Combined_Executive_Summaries_PISA_2022.pdf

Palinussa, A. L., Molle, J. S., & Gaspersz M. (2021). Realistic mathematics education: mathematical reasoning and communication skills in rural contexts. *IJERE*, *10*(2), 522-534.

Purba, G. F., Rohana, A., Sianturi, F., Giawa, M., Manik, E. & Situmorang, A. S. (2022). Implementasi pendekatan pendidikan matematika realistik indonesia (PMRI) pada konsep merdeka belajar [Implementation of the Indonesian realistic mathematics education (PMRI) approach to the concept of independent learning]. *SEPREN*, *4*(1), 23-33.

Putra, Y. Y. & Vebrian, R. (2019). Pengembangan soal matematika model PISA konteks kain Cual Bangka Belitung [Development of PISA model mathematical questions in the context of Cual Bangka Belitung fabric]. *Journal Cendekia: Jurnal Pendidikan Matematika*, 3(2), 333-340. https://doi.org/10.31004/cendekia.v3i2.114

Risnawati, Mardianita, W., dan Hernety. (2016). Pengembangan LKS pemecahan masalah kaidah pencacahan dengan pendekatan metakognitif untuk SMA kelas XI [Development of enumeration rule problem solving worksheets with a metacognitive approach for class XI high school]. *Jurnal Penelitian dan Pembelajaran Matematika*, *9*(1), 138-144. http://dx.doi.org/10.30870/jppm.v9i1.99

Sembiring, R., Hoogland, K., & Dolk, M. (Eds.). (2010). *A decade of PMRI in Indonesia. APS International.*

Syaiful, D. (2005). *Guru dan anak didik dalam interaksi edukatif [Teachers and students in educational interactions].* Rineka Cipta.

Tessmer, M. (1993). *Planning and conducting formative evaluation.* London Kogan Page.

Tessmer, M. (1999). *Planning and conducting formative evaluation: improving the quality of education and training. London, Philadelphia:* Kogan Page.

Utari, R. S. (2017). Desain pembelajaran materi perbandingan menggunakan konteks resep empek-empek untuk mendukung kemampuan bernalar siswa SMP [The comparative material learning design uses the context of empek-empek recipes to support junior high school students' reasoning abilities]. *Jurnal Pendidikan Matematika RAFA*, *3*(1), 103-121.

Van den Akker, J., Bannan, B, dkk. (2013). *Educational design research.* Enschede: Netherlands Institute for Curriculum Development (SLO). https://slo.nl/publish/pages/2904/educational-design-researchpart-a.pdf

Vebrian, R., Putra, Y.Y., dkk. (2021). Kemampuan penalaraan matematis siswa dalam menyelesaikan soal literasi matematika kontekstual [Students' mathematical reasoning abilities in solving contextual mathematical literacy problems]. *Aksioma: Jurnal Program Studi Pendidikan Matematika*, *10*(4), 2602-2614. http://dx.doi.org/10.24127/ajpm.v10i4.4369

Wati, T., Zulkardi & Susanti, E. (2015). Pengembangan bahan ajar PMRI topik literasi finansial pada aritmatika sosial kelas VII [Development of PMRI teaching materials on the topic of financial literacy in class VII social arithmetic]. *Jurnal Pendidikan Matematika*, *9*(1), 990-1005. https://doi.org/10.22342/jpm.9.1.2129.22%20-%2034

Zulkardi, & Putri, R. I. I. (2010). Pengembangan *blog support* untuk membantu siswa dan guru Indonesia belajar pendidikan matematika realistik indonesia [Development of blog support to help Indonesian students' and teachers learn realistic Indonesian mathematics education]. Balitbang. http://repository.unsri.ac.id/id/eprint/6777

Zulkardi, & Putri, R. I. I. (2006). Mendesain sendiri soal kontekstual matematika [Design your own contextual mathematics questions]. *Prosiding KNM13. Semarang.* http://eprints.unsri.ac.id/610/

Zulkardi. (2002). Developing a learning environment on realistic mathematics education for Indonesian student teachers. *Disertasi Doktor, University of Twente, Enschede.* http://repository.unsri.ac.id/id/eprint/871