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Students' mathematical modelling ability in solving PISA tasks on uncertainty and data content

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Abstract

Mathematical modeling is key in helping students connect abstract mathematics with real-life situations by transforming practical problems into mathematical forms, solving them analytically, and interpreting solutions in context. This study investigates junior high school students' mathematical modeling abilities in solving PISA tasks on Uncertainty and Data, analyzed through the OECD (2018) framework of formulating, employing, interpreting, and evaluating. Employing a descriptive qualitative approach, we collected data through written tests and follow-up interviews with seventh-grade students. Findings reveal that students show moderate ability in employing mathematical procedures (50.2%) but struggle with formulating problems (45.3%). Most critically, they demonstrate significant difficulties in interpreting (33.7%) and evaluating (28.5%) solutions within real-world contexts, impairing their ability to apply mathematics practically. Qualitative analysis of written tests and interviews shows that students often develop mental strategies but fail to articulate them in writing. These findings underscore the critical need to strengthen higher-order modeling skills in instructional practices, particularly interpretation, evaluation, and mathematical communication. The study reveals essential gaps between procedural competence and practical application, suggesting that curriculum reforms should emphasize problem-solving approaches to develop mathematical modeling abilities that meet PISA's standards.

Keywords: mathematical modeling; PISA; uncertainty; data

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I. Introduction

The role of mathematics in education extends beyond conceptual mastery, fostering essential skills like logical, analytical, and systematic thinking that empower students to make informed decisions and solve real-world problems (Daulay, Patwal, Wahyudi, & Ritonga, 2025). As the world becomes increasingly complex, mathematics learning is no longer centered only on using formulas and procedures (Murdikah, Sudaryana, Hardiana, & Nurfitriyah, 2021). Instead, it is now directed toward cultivating students' abilities to understand and solve contextual problems in meaningful ways (Yadih, Salsabila, & Murdiyanto, 2023). One of the key abilities in this regard is mathematical modeling. This refers to students' capacity to represent real-world phenomena using mathematics, solve the resulting problems, and interpret the solutions within the original context (Kurniadi, Darmowijoyo, & Pratiwi, 2020).

The importance of mathematical modeling becomes even more apparent when viewed through the lens of international assessments such as the Programme for International Student Assessment or PISA. The 2022 PISA framework classifies mathematics into four main content areas. Change and Relationship, Space and Shape, Quantity, Uncertainty, and Data (OECD, 2023). Unfortunately, Indonesia continues to perform poorly, ranking seventy-second out of eighty-one participating countries. Only eighteen percent of Indonesian students can achieve the baseline level of mathematical proficiency, Level Two (Ramadhan & Rozak, 2024; Siregar et al., 2024). These results indicate that many students in Indonesia have difficulty applying their mathematical knowledge to real-world problems, a central feature of both mathematical literacy and modeling (Nurmaya, Muzdalipah, & Heryani, 2022). This issue indicates the need for instructional strategies promoting higher-order mathematical thinking (Nuryadi, Santoso, & Indaryanti, 2018).

Alongside international assessment outcomes, attention must be given to how national curriculum policies contribute to students' mathematical modeling competence. While the Merdeka Curriculum and the 2013 Curriculum aim to promote contextual learning, classroom practices often focus on procedural skills and final answers, neglecting the process of mathematical modeling (Nurindah & Hidayati, 2021; Ramadhani, Siregar, & Rajagukguk, 2024). This suggests a disconnect between curriculum intent and implementation, which may limit opportunities for students to engage meaningfully in modeling activities (Sari & Ralmugiz, 2020).

This disconnect between curriculum intent and classroom practices is particularly evident in the PISA content area of Uncertainty and Data, which is crucial for assessing students' ability to apply mathematical reasoning in real-world contexts. Among the four content areas in PISA, uncertainty and data are especially relevant for assessing real-life applications and reasoning (Saputri, Turidho, Zulkardi, Darmawijoyo & Somakim, 2020). According to the OECD (2023) this content area lies at the core of mathematical analysis in many situational problems. It involves using probability and statistics to organize, describe, and interpret data. As such, it challenges students to understand mathematical concepts and build mathematical models from situations that involve uncertainty or data-based reasoning. However, research has shown that many students experience difficulties in this area.

Numerous studies have documented these difficulties that explore student performance in uncertainty and data modeling tasks. Sumarni, et al., (2023) found that students often encounter challenges constructing appropriate mathematical models for uncertainty and data problems. Setiawati, Aminudin, & Basir, (2023) reported that students with lower achievement levels tend to solve problems without structure and fail to reach accurate conclusions. Masfufah & Afriansyah (2021) observed that students frequently struggle to identify essential information and transform it into mathematical representations. Similarly, Sujadi et al. (2022) revealed that modeling errors often arise from a lack of contextual understanding. These findings highlight the need to explore further students' modeling processes in tasks involving uncertainty and data.

Theoretical perspectives highlight that mathematical modeling is a complex process involving understanding real-life problems, identifying relevant variables, describing their relationships, constructing mathematical models, solving the problems, formulating mathematically structured questions, and interpreting the results (Bliss & Libertini, 2016; Niss & Blum, 2020). According to Maaß (2006), this process can be broken down into four stages: understanding the problem, building the model, finding the solution, and interpreting the outcome. This shows that modeling requires calculation skills, conceptual reasoning, and the ability to reflect on results.

Although previous research has identified general difficulties students face in mathematical modeling, few studies have examined how Indonesian junior high school students specifically engage with each modeling phase as defined by the OECD framework. This study aims to examine their mathematical modeling abilities in solving PISA tasks related to uncertainty and data, focusing on three key processes: formulating real-world problems into mathematical models, employing appropriate mathematical concepts and procedures, and interpreting and evaluating the results within the original context. Using the OECD (2023) framework as an analytical lens, this research seeks to reveal students' strengths and weaknesses across these phases, thereby providing insights to support more targeted and effective instructional strategies.

II. Research Method

This study employs a descriptive qualitative approach to examine the mathematical modeling abilities of seventh-grade students in solving PISA tasks related to uncertainty and data content. Participants were purposively selected based on recommendations from the mathematics teacher regarding their average mathematics achievement and the student's willingness to participate in the study. Before data collection, informed consent was obtained from the students and their parents or guardians, ensuring voluntary participation. Confidentiality of the participants' identities and responses was maintained throughout the study. Data were collected through a written test consisting of PISA problems to measure students' abilities in three key aspects of mathematical modeling: formulating problems mathematically, employing mathematical concepts and procedures, and interpreting and evaluating results.

To gain deeper insights into students' thinking processes and problem-solving strategies, in-depth semi-structured interviews were conducted with selected students after the test administration. The interviews lasted approximately 15 minutes and were designed to explore students' reasoning in more detail. Students were selected for interviews based on their test performance, representing a range of problem-solving abilities. The data collection procedure began with a written test consisting of PISA questions and individual interviews. The test included two questions specifically selected to assess the four aspects of mathematical modeling: formulating situations mathematically, using mathematical concepts and procedures, and interpreting and evaluating results. The test data were analyzed descriptively using a qualitative approach to explore students' proficiency levels based on predetermined scoring categories, while interview data were analyzed qualitatively using content analysis. The process began with verbatim transcription of the interviews, followed by manual coding, grouping, and systematic interpretation of the data according to the mathematical modeling framework outlined by OECD (2023).

The following table presents the indicators of mathematical modeling ability as defined by OECD (2023), which serve as the analytical framework for this study:

Table 1
Mathematical modelling ability indicators

Modelling Process	Ability Indicators
Formulate	Able to understand real-world situations, identify relevant information, and translate problems into mathematical form
Employ	Able to apply appropriate mathematical concepts, principles, and procedures to solve problems
Interpret	Able to accurately connect mathematical results back to the original problem context
Evaluate	Able to assess the accuracy, appropriateness, and limitations of mathematical solutions within the problem context

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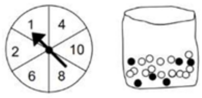
III. Results and Discussion

In this study, students were asked to solve two PISA problems on uncertainty and data content made in 2006 to assess their mathematical modeling ability.

1. A game in a booth at a spring fair involves using a spinner first. Then, if the spinner stops on an even number, the player is allowed to pick a marble from a bag. The spinner and the marbles in the bag are represented in the diagram below.



Prizes are given when a black marble is picked. Sue plays the game once.
How likely is it that Sue will win a prize?
A. Impossible
B. Not very likely
C. About 50% likely
D. Very likely

2. A documentary was broadcast about earthquakes and how often earthquakes occur. It included a discussion about the predictability of earthquakes. A geologist stated: "In the next twenty years, the chance that an earthquake will occur in Zed City is two out of three".
Which of the following best reflects the meaning of the geologist's statement?
A. $\frac{2}{3} \times 20 = 13{,}3$, so between 13 and 14 years from now there will be an earthquake in Zed City
B. $\frac{2}{3}$ is more than $\frac{1}{2}$, so you can be sure there will be an earthquake in Zed City at some time during the next 20 years.
C. The likelihood that there will be an earthquake in Zed City at some time during the next 20 years is higher than the likelihood of no earthquake.
D. You cannot tell what will happen, because nobody can be sure when an earthquake will occur.

Figure 1. PISA questions

Based on Figure 1, In question 1, students were asked to evaluate compound probability by analyzing the chance that a spinner lands on an even number and then selecting a black marble from a bag. This question assesses students' ability to understand and combine two independent probabilistic events in a real-life game scenario. In Question 2, students were asked to interpret a probabilistic statement made by a geologist regarding the likelihood of an earthquake occurring within the next twenty years. This question assesses their ability to reason about probability expressed in everyday language and to evaluate how such statements reflect uncertainty and likelihood in real-world contexts.

Based on the test results and the evaluation using the assessment rubric, the researcher categorized students according to the criteria for mathematical modeling ability adopted from OECD (2023), as shown in Table 1:

Table 2
Percentage of student's mathematical modeling skills.

Score	Category	Frequency	Percentage
81-100	Very Good	3	12,5%
61-80	Good	3	12,5%
41-60	Enough	9	37,5%
21-40	Bad	5	25%
0-20	Very Bad	3	12,5%
Total		24	100%

(Ambarita, Asri, Agustina, Octavianty, & Zulkardi, 2018)

Based on the mathematical modeling ability test results shown in Table 1, 12.5% of the participants were classified as excellent, as they could fulfill all modeling indicators. Another 12.5% were categorized as good, demonstrating fairly consistent modeling steps. Meanwhile, 37.5% fell into the moderate category, showing partial understanding. A total of 25% were classified as poor, as they only simplified the problem without completing the whole modeling process, and 12.5% were categorized as very poor, merely copying information without understanding. Overall, students' mathematical modeling ability to solve the PISA problems was moderate.

The following section presents the analysis of the test and interview data, along with the discussion. Students' achievement of the modeling indicators can be seen in the table below. Mathematical modeling ability consists of four indicators: formulate, employ, interpret, and evaluate. The table shows the frequency of students in each aspect of modeling ability.

Table 3
Achievement of student mathematical modeling indicators.

No.	Indicator			
	Formulate	Employ	Interpret	Evaluate
1	65,5%	55%	40,5%	35%
2	45%	60,5%	35%	30,5%
3	25,5%	35%	25,5%	20%
Avg.	45,3%	50,2%	33,7%	28,5%

Table 3 shows students' achievement across the four indicators of mathematical modeling based on three questions. The 'Employ' indicator has the highest average (50.2%), indicating that students are fairly capable of applying mathematical models. The 'Formulate' indicator (45.3%) suggests that students still face difficulties in formulating problems. The 'Interpret' (33.7%) and 'Evaluate' (28.5%) indicators have the lowest averages, indicating that students are still weak in interpreting results and assessing the accuracy of models. These findings highlight the need to strengthen interpretation and evaluation skills in mathematical modeling instruction.

The following are some student responses that are interesting to discuss further. AAR's response to the PISA question is presented in Figure 2.

AAR'S answer (high ability student)

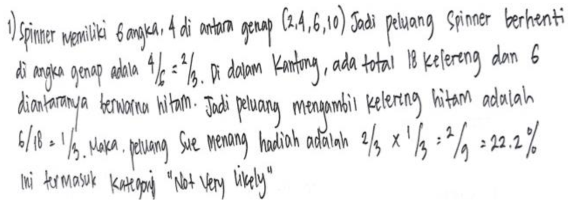

1) Spinner memiliki 6 angka, 4 di antara genap (2,4,6,10) Jadi peluang Spinner berhenti di angka genap adala 4/6 = 2/3. Di dalam Kantong, ada total 18 kelereng dan 6 diantaranya berwarna hitam. Jadi peluang mengambil kelereng hitam adalah 6/18 = 1/3. Maka, peluang Sue menang hadiah adalah 2/3 x 1/3 = 2/9 = 22.2% ini termasuk kategori "Not Very likely"

Figure 2. AAR's answer to the question

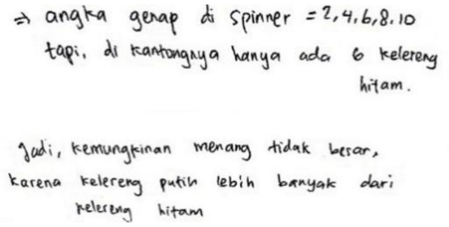
As shown in Figure 2, AAR demonstrated high mathematical modeling ability. The student identified key information from the problem and translated it into a mathematical model by calculating the probability of the spinner landing on even numbers and then the probability of drawing a black marble (formulate and employ). S/he multiplied both probabilities correctly and interpreted the result as 22.2%, concluding that the event is "not very likely" (interpret). The student also evaluated the situation by categorizing the result within a contextual framework ("not very likely"), showing the ability to reflect on and assess the reasonableness of the answer (evaluate).

Researcher	:	Can you explain how you solved this problem?
AAR	:	First, I found the probability that the spinner would stop on an even number, 4 out of 6, so 2/3.
Researcher	:	Then?
AAR	:	Then, 6 out of 18 black marbles are in the bag, so the probability of picking a black marble is 1/3.
Researcher	:	How did you determine Sue's probability of winning?
AAR	:	I multiplied 2/3 × 1/3 to get 2/9, which is 22.2%.
Researcher	:	Why did you conclude that?
AAR	:	Because 22% is small, the probability of winning is not very big.

From the results of the researcher's interview with AAR, S/he could identify all relevant information from the problem and correctly develop a plan to solve it. AAR calculated the probability of the spinner landing on an even number and the probability of drawing a black marble, then combined the probabilities to determine the overall chance of winning. AAR could also interpret the result contextually and classify the likelihood appropriately. This indicates a high ability level in all four aspects of mathematical modeling.

The NK's answer to PISA questions is presented in Figure 3.

NK'S answer (middle ability student)


⇒ angka genap di spinner = 2,4,6,8,10
tapi, di kantongnya hanya ada 6 kelereng hitam.

Jadi, kemungkinan menang tidak besar, karena kelereng putih lebih banyak dari kelereng hitam

Figure 3. NK's answer to the question

Based on the written response shown in Figure 3, NK was categorized as a student with moderate mathematical modeling ability. S/he identified relevant mathematical elements, such as even numbers on the spinner, and compared them with the number of black marbles (formulate). However, there is no attempt to

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calculate exact probabilities, which suggests a partial use of mathematical models (employ). The conclusion was qualitatively correct, stating that the chance to win is low, which shows some ability to interpret the situation (interpret), but the justification remains verbal and lacks formal evaluation or confirmation (evaluate).

Researcher	:	Can you explain how you worked on this problem?
NK	:	I saw several even numbers on the spinner and only a few black marbles, so I thought the chance of winning was small.
Researcher	:	Did you calculate the odds?
NK	:	I did not calculate it precisely, but I just compared the numbers; there were more white marbles.
Researcher	:	So you concluded that the chance of winning was small from that comparison?
NK	:	Yes, the chance was slight because there were only 6 black marbles.

From the results of the researcher's interview with NK, S/he was able to identify some key information from the problem and make qualitative comparisons. Although NK did not calculate exact probabilities, NK could interpret the situation and recognize that the number of black marbles was relatively low, which reduced the chance of winning. This shows a moderate level of ability in interpreting and evaluating, though the use of formal mathematical procedures was still lacking.

The DA's answer to PISA questions is presented in Figure 4.

DA'S answer (low ability student)

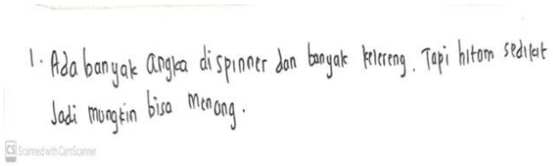
1. Ada banyak angka di spinner dan banyak kelereng. Tapi hitam sedikit Jadi mungkin bisa menang.

Figure 4. DA's answer to the question

Based on the student's written work in Figure 4, DA was categorized as having low mathematical modeling ability. S/he provided a very general and intuitive response without clearly identifying the known and asked information from the problem (formulation). The answer lacked any mathematical representation or calculations, showing no evidence of applying a mathematical model (employ). The reasoning indicates an attempt to interpret without sufficient depth or connection to the data (interpret). There is no evaluation of results (evaluate), indicating that the student did not fully engage with the modeling cycle.

Researcher	:	How did you solve this problem?
DA	:	I saw that the spinner had a lot of numbers and marbles, too, so maybe she could win.
Researcher	:	Did you calculate Sue's chances of winning?
DA	:	No, I saw that she could win because there were many numbers.
Researcher	:	Does the number of marbles affect the chances of winning?
DA	:	If there are only a few, it might be hard to win.

The researcher's interview with Student DA revealed that DA had difficulty identifying important information in the problem. DA relied only on general impressions without analyzing the quantities or relationships given. S/he did not attempt to formulate a plan or use a mathematical model to solve the problem. This indicates a low level of ability in formulating and evaluating the situation mathematically.

Based on the findings of this study, indicators of students' mathematical modeling ability emerged after the implementation of the PISA mathematics tasks. A more detailed explanation of the indicators identified in this study is presented below

Formulate

Based on the researchers' findings, the indicator of mathematical modeling skills that often appears is formulated, where it was found that students could identify important information from the problem and translate it into mathematical elements, such as identifying relevant quantities or determining what was being asked. This shows that students could understand the context of the problem and begin constructing an appropriate mathematical model. As stated by Novita & Hamimi (2024), formulating involves grasping the problem and transforming it into a mathematical form. However, several students were still limited to identifying only partial information and did not proceed to develop a complete plan to solve the problem mathematically. Similar findings were also reported by Bidasari (2017), who found that although students could recognize key elements, they often had difficulty organizing them into a coherent problem-solving structure. Sometimes, students rely on intuition rather than structuring the problem (Yosep, Kristanto, & Manoy, 2020).

Employ

Based on the researchers' findings, the indicator of mathematical modeling skills that sometimes appears is employed. Some students could apply appropriate mathematical procedures, such as calculating probabilities or combining numerical values according to their formulated model. This shows that they could operate within the mathematical structure they had built. As Suharyono & Rosnawati (2020) described, the employ stage involves working mathematically to process information and generate results. However, many students did not perform accurate calculations or skipped mathematical operations altogether, indicating limited engagement with this phase. According to Bryant et al. (2020), students often struggle to link their understanding of the context with appropriate mathematical operations. Additionally, Usodo et al. (2020) noted that although students may understand the problem, they frequently encounter obstacles in carrying out the correct calculations due to conceptual or procedural errors.

Interpret

Based on the researchers' findings, the indicator of mathematical modeling skills that often appears is interpretation, and it was found that students could connect the mathematical results to the context of the problem. Some students could conclude whether an event was likely or not based on their calculations or general observations. As explained by Krawitz, Chang, Yang, & Schukajlow, (2022), interpretation refers to making sense of the mathematical results in relation to the original real-world situation. In several cases, even when students did not show complete calculations, they could still provide reasonable qualitative interpretations based on the context. This aligns with the findings of Kolar & Hodnik (2021), who emphasized that students sometimes rely on contextual understanding rather than formal mathematics. However, some students were limited in depth and failed to fully justify their conclusions using mathematical evidence (Mejía-Ramos & Weber, 2020).

Evaluate

Based on the researchers' findings, the indicator of mathematical modeling skills that rarely appears is evaluation. While some students could check whether their answers made sense within the problem context, most did not reflect on the correctness or efficiency of their strategies (Utami, Zulkardi, & Putri, 2023). As Abassian, Safi, Bush, & Bostic, (2020) described, evaluation involves assessing the validity of the mathematical solution both mathematically and contextually. Students often did not revisit their answers to confirm whether the results were reasonable, and some assumed that once they obtained a numerical result, the problem was solved completely. Similar findings were highlighted by Rahmatika (2022), who reported that students tend to overlook the process of reflection and justification. Moreover, according to Chamberlin, Payne, & Kettler, (2020), the evaluation phase is often skipped because students are not accustomed to reviewing or questioning their reasoning in mathematical modeling tasks.

Based on the data analysis, students showed varied abilities in the mathematical modeling stages: formulating, employing, interpreting, and evaluating. The highest average was employment (50.2%), indicating students could apply mathematical procedures well (Susanta, Koto, & Susanto, 2023; Zulkardi et al., 2020). The formulate indicator averaged 45.3%, showing some ability to identify relevant information, though difficulties remained. The lowest scores were in interpretation (33.7%) and evaluation (28.5%), showing that students struggle to relate results to real contexts and assess solution accuracy (Kusmaryono & Kusumaningsih, 2023). This suggests a need for a stronger focus on reflective problem-solving in teaching. Interviews suggested some students mentally planned and reflected on strategies but rarely documented these steps in writing. Students' mathematical modeling skills in solving PISA on uncertainty and data content can be classified as moderate. However, this classification reflects varied levels of proficiency across different modeling indicators. In particular, students performed stronger in formulating and employing mathematical concepts, while interpreting and evaluating remained weaker. This suggests the need for targeted instructional strategies to support and strengthen these specific aspects of mathematical modeling.

IV. Conclusion

The mathematical modeling ability of junior high school students in solving PISA mathematics problems on uncertainty and data content is classified as moderate. The most frequently appearing indicator is employment, which indicates that students can apply mathematical procedures effectively. The formulate indicator shows that students still have difficulty in formulating problems completely. Meanwhile, the interpret and evaluate indicators appear the least, indicating that students are still weak in interpreting the results of their calculations in context and in evaluating the accuracy or fairness of their answers. Some students can plan and reflect on their strategies mentally but rarely express them explicitly in writing. Thus, although students have begun to engage in the mathematical modeling process, they still need support to strengthen their interpretation, evaluation, and written reasoning skills.

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References

Abassian, A., Safi, F., Bush, S., & Bostic, J. (2020). Five different perspectives on mathematical modeling in mathematics education. *Investigations in Mathematics Learning*, *12*(1), 53–65. https://doi.org/10.1080/19477503.2019.1595360

Ambarita, S. M., Asri, L., Agustina, A., Octavianty, D., & Zulkardi, Z. (2018). Mathematical modeling skills on solving PISA problems. *Journal of Physics: Conference Series*, *1097*(1). https://doi.org/10.1088/1742-6596/1097/1/012115

Bidasari, F. (2017). Pengembangan soal matematika model PISA pada konten quantity untuk mengukur kemampuan pemecahan masalah matematika siswa sekolah menengah pertama. *Jurnal Gantang*, *II*(1), 63–77. https://doi.org/10.31629/jg.v2i1.59

Bliss, K., & Libertini, J. (2016). Consortium for mathematics and its applications; society for industrial and applied mathematics. *GAIMME: Guidelines for assessment & instruction in mathematical modeling education*.

Bryant, D. P., Bryant, B. R., Dougherty, B., Roberts, G., Pfannenstiel, K. H., & Lee, J. (2020). Mathematics performance on integers of students with mathematics difficulties. *Journal of Mathematical Behavior*, *58*(100776), 1–13. https://doi.org/10.1016/j.jmathb.2020.100776

Chamberlin, S., Payne, A. M., & Kettler, T. (2020). Mathematical modeling: a positive learning approach to facilitate student sense-making in mathematics. *International Journal of Mathematical Education in Science and Technology*, 1–14. https://doi.org/10.1080/0020739X.2020.1788185

Daulay, A. S., Patwal, A., Wahyudi, B., & Ritonga, P. M. (2025). Pengembangan kemampuan berpikir logis dan analitis dalam pengambilan keputusan generasi Z di era digital. *Jurnal Pendidikan Tambusai*, *9*(1), 5074–5079.

Kolar, V. M., & Hodnik, T. (2021). Mathematical literacy from the perspective of solving contextual problems. In *European Journal of Educational Research* (Vol. 10, Issue 1, pp. 467–483). Eurasian Society of Educational Research. https://doi.org/10.12973/eu-jer.10.1.467

Krawitz, J., Chang, Y. P., Yang, K. L., & Schukajlow, S. (2022). The role of reading comprehension in mathematical modeling: improving the construction of a real-world model and interest in Germany and Taiwan. *Educational Studies in Mathematics*, *109*(2), 337–359. https://doi.org/10.1007/s10649-021-10058-9

Kurniadi, E., Darmowijoyo, D., & Pratiwi, W. D. (2020). Analisis kemampuan pemahaman konsep dasar mahasiswa dalam mengidentifikasi karakteristik dan menyelesaikan soal pemodelan matematika. *Jurnal Gantang*, *5*(1), 9–18. https://doi.org/10.31629/jg.v5i1.299

Kusmaryono, I., & Kusumaningsih, W. (2023). Evaluating the results of PISA assessment: are there gaps between the teaching of mathematical literacy at schools and in PISA assessment?. *European Journal of Educational Research*, *12*(3), 1479–1493. https://doi.org/10.12973/eu-jer.12.3.1479

Maaß, K. (2006). What are modeling competencies?. *ZDM - International Journal on Mathematics Education*, *38*(2), 113–142. https://doi.org/10.1007/BF02655885

Masfufah, R., & Afriansyah, E. A. (2021). Analisis kemampuan literasi matematis siswa melalui soal PISA. *Mosharafa: Jurnal Pendidikan Matematika*, *10*(2), 291–300. https://doi.org/10.31980/mosharafa.v10i2.662

Mejía-Ramos, J. P., & Weber, K. (2020). Using task-based interviews to generate hypotheses about mathematical practice: mathematics education research on mathematicians' use of examples in proof-related activities. *ZDM - Mathematics Education*, *52*(6), 1099–1112. https://doi.org/10.1007/s11858-020-01170-w

Murdikah, A., Sudaryana, T., Hardiana, L., & Nurfitriyah, A. (2021). Tinjauan penerapan teori skemp terhadap pemahaman fungsi invers pada guru matematika. *TIRTAMATH: Jurnal Penelitian Dan Pengajaran Matematika*, *2*. https://doi.org/10.48181/tirtamath.v3i2.11172

Niss, M., & Blum, W. (2020). *The learning and teaching of mathematical modelling*. Routledge. https://doi.org/10.4324/9781315189314

Novita, E., & Hamimi, L. (2024). Analisis kemampuan literasi matematis siswa SMP pada materi teorema phytagoras. *Kognitif: Jurnal Riset HOTS Pendidikan Matematika*, *4*(2). https://doi.org/10.51574/kognitif.v4i2.1849

Nurindah, N., & Hidayati, N. (2021). Analisis kesulitan siswa berdasarkan kemampuan pemahaman konsep matematis dalam menyelesaikan soal materi SPLDV. *Jurnal Cendekia: Jurnal Pendidikan Matematika*, *6*(1), 24–34. https://doi.org/10.31004/cendekia.v6i1.981

Nurmaya, R., Muzdalipah, I., & Heryani, Y. (2022). Analisis proses literasi matematis siswa dalam menyelesaikan soal model asesmen kompetensi minimum. *Teorema: Teori Dan Riset Matematika*, *7*(1), 13. https://doi.org/10.25157/teorema.v7i1.6378

Nuryadi, A., Santoso, B., & Indaryanti, I. (2018). Kemampuan pemodelan matematika siswa dengan strategi scaffolding with a solution plan pada materi trigonometri di kelas X SMAN 2 Palembang. *Jurnal Gantang*, *3*(2), 73–81. https://doi.org/10.31629/jg.v3i2.468

OECD. (2023). *PISA 2022 assessment and analytical framework*. OECD. https://doi.org/10.1787/dfe0bf9c-en

Rahmatika, A. (2022). The effect of think-talk-write cooperative learning assisted by geogebra software on students' critical thinking (case study of SMA AL-HIDAYAH Medan). *IJEMS: Indonesian Journal of Education and Mathematical Science*, *3*(1), 1. https://doi.org/10.30596/ijems.v3i1.9877

Ramadhan, H. N. J., & Rozak, A. (2024). Implementasi realistic mathematic education (RME) dalam upaya peningkatan kemampuan numerasi siswa kelas IV di SDN Jatirejo Diwek Jombang. *LAPLACE: Jurnal Pendidikan Matematika*, *1*(1).

Ramadhani, N., Siregar, J. M., & Rajagukguk, W. (2024). Tren pendidikan matematika berdasarkan perubahan kurikulum dari tahun 2006 SD 2024 tingkat SMA. *Jurnal Ilmiah Widya Pustaka Pendidikan*, *12*(1), 51–61.

Saputri, N. W., Turidho, A., Zulkardi, Z., Darmawijoyo, D., & Somakim, S. (2020). Desain soal PISA konten uncertainty and data konteks penyebaran COVID-19. *EDU-MAT: Jurnal Pendidikan Matematika*, *8*(2), 106–118.

Sari, D. K., & Ralmugiz, U. (2020). Analisis kemampuan pemodelan matematis peserta didik pada mata pelajaran fisika. *MEGA: Jurnal Pendidikan Matematika*, *1*(2), 88–93. https://doi.org/10.59098/mega.v1i2.218

Setiawati, R., Aminudin, M., & Basir, M. A. (2023). Analisis literasi numerasi peserta didik dalam menyelesaikan masalah uncertainty and data. *JPSA - Jurnal Pendidikan Sultan Agung*, *3*(2), 123–133. https://doi.org/10.30659/jp-sa.3.2.123-133

Siregar, B. H., Sinaga, S. M., Andini, P., Masita, N., Fadilla, N., Nainggolan, G. L., … Siregar, D. A. (2024). Analisis kesalahan siswa dalam menyelesaikan soal hots materi sistem pertidaksamaan linear dua variabel: perspektif teori kastolan. *JagoMIPA: Jurnal Pendidikan Matematika Dan IPA*, *4*(4), 798–807. https://doi.org/10.53299/jagomipa.v4i4.926

Suharyono, E., & Rosnawati, D. R. (2020). Analisis buku teks pelajaran matematika SMP ditinjau dari literasi matematika. *Mosharafa: Jurnal Pendidikan Matematika*, *9*(3), 451–462. https://doi.org/10.31980/mosharafa.v9i3.628

Sujadi, I., Budiyono, B., Kurniawati, I., Wulandari, A. N., Andriatna, R., Puteri, H. A., & Nurmalitasari, A. (2022). Kesulitan siswa sekolah menengah pertama dalam menyelesaikan soal matematika PISA-Like. *Edukasi: Jurnal Pendidikan*, *20*(2), 315–328.https://doi.org/10.31571/edukasi.v20i2.4781

Sumarni, S., Adiastuty, N., Riyadi, M., Nisa, D. K., Restu, A. M., & Lestari, I. T. (2023). Analisis kemampuan literasi matematika siswa smp dalam mengerjakan soal PISA uncertainty and data content. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(1), 725.

https://doi.org/10.24127/ajpm.v12i1.6426

Susanta, A., Koto, I., & Susanto, E. (2023). Mathematics PISA problems using local context for elementary school students. *Jurnal Gantang*, *8*(1), 11–19. https://doi.org/10.31629/jg.v8i1.5604

Usodo, B., Aulia, I. I., Wulandari, A. N., Sutopo, Setiawan, R., Kurniawati, I., & Kuswardi, Y. (2020). Fragmentation of thinking structure and its impact on students' algebraic concept construction and problem-solving. *Journal of Physics: Conference Series*, *1567*(3). https://doi.org/10.1088/1742-6596/1567/3/032006

Utami, M. R. P., Zulkardi, Z., & Putri, R. I. I. (2023). Students' critical thinking skills in solving PISA-Like Questions in the Context of the jakabaring Palembang tourism. *Jurnal Pendidikan Matematika*, *17*(2), 135–148.

Yadih, A., Salsabila, E., & Murdiyanto, T. (2023). Pengaruh pendekatan kontekstual dengan strategi think talk write terhadap kemampuan pemecahan masalah matematis siswa SMA Negeri 1 Jakarta. *Jurnal Riset Pembelajaran Matematika Sekolah*, *7*. https://doi.org/10.21009/jrpms.071.06

Yosep, H., Kristanto, W., & Manoy, J. T. (2020). Representasi matematis siswa SMA dalam menyelesaikan masalah matematika ditinjau dari gaya kognitif sistematis dan intuitif. *JPPMS: Jurnal Penelitian Pendidikan Matematika Dan Sains*, *4*(2), 50–59. https://doi.org/10.26740/jppms.v4n2.p50-59

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