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Controversial Mathematical Issues : Problem Based Learning on Critical Thinking

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Abstract: This study aims to describe the study of controversial mathematical issues as problems that facilitate cognitive conflict and metacognitive knowledge. The research method used is a Systematic Literature Review with the process of identifying, assessing, and interpreting the available research facts, with the research object being a mathematical problem. The research design used was to summarize, review, and analyze 27 articles relevant to the research object in Sinta-accredited journals, indexed by Scopus and Web of Science. Then, these articles were analyzed using content analysis techniques. From the Systematic Literature Review, the results showed that controversial problems were different from metacognitive problems and the problems that facilitate cognitive conflict. These unique problems suit the mathematical problems' criteria and support the application of Problem-Based Learning.

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Introduction

Critical thinking is a higher-order thinking skill that involves cognitive processes such as finding problem-solving, making decisions, persuading, and analyzing assumptions (Sari &; Hidayat, 2019), (Pratiwi et al, 2022). Critical thinking skills are important in solving mathematical problems because, with this skill, students can find the most effective solution to a problem by processing known information in the problem (Samura et al., 2020), (Hidayati et al., 2023). In the context of mathematics learning, critical thinking can increase creative problem-solving options because it can encourage students to find new strategies for solving problems (Harjo et al., 2019), (Musdi et al., 2020). One of the things obtained from the Systematic Literature Review (Suryawan et al., 2022) is that research's tendency to bring up critical thinking is dominated by applying Problem-Based Learning (PBL).

Problem-Based Learning is an effective learning model for developing students' critical thinking because this learning model focuses on applying problems that facilitate students to experience cognitive processes in solving problems and gain important knowledge from the concept of the material to be strengthened (Ardhianto et al., 2020), (Ramadhani et al., 2020), (Susilo et al., 2020). In its application, the problems used in PBL are designed to direct students to be proficient in solving problems, have individual learning strategies, and can participate in teams (Hotimah, 2020), (Aini et al., n.d.). However, from the results of the article analysis by (Ismail, 2018), (Susanti &; Hartono, 2019), the problems used in the application of PBL are only limited to their contextual tendencies and have not optimally generated cognitive conflicts and metacognitive knowledge so that the development of students' critical thinking has not been maximized (Sutopo, 2021).

Cognitive conflict refers to situations when students face a mismatch between the cognitive elements that students have with new information or ideas obtained (Lestary R. et

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al., 2018), (Firmanti, P., 2022). The emergence of cognitive conflict is one of the crucial factors in the development of critical thinking because the emergence of conflict can change the thinking structure of students (Walida et al., 2022). Furthermore, although it can facilitate critical thinking through the emergence of opposition, the cognitive conflict has not accommodated the ability to reflective thinking through metacognition problems. According to (Saputra, N. &; Andriyani, R., 2018) and (Murni A. et al., 2019), the metacognitive ability is the ability to think with the object of thinking is the thought process itself. By practicing metacognitive skills, students can develop reflective thinking skills because this type of ability can lead students to review problems with their already existing knowledge (Walida et al., 2022). However, the development of metacognitive abilities has not maximally facilitated students' critical thinking because the problems used tend to be contextual and have not caused conflicts that can build students' thinking structures (Halimah et al., 2019), (Permatasari et al. et al., 2020). Based on these limitations, a problem is needed to accommodate cognitive conflicts expressed in metacognition (Danila &; Agustini, 2021).

Subanji et al. (2021) recommend a type of reasoning called controversial reasoning, which facilitates the process of reflective and critical thinking. It is supported by research (Rosyadi et al., 2021) which states that controversial reasoning can foster students' reflective thinking and critical thinking skills because it involves a process of identification, analysis, and evaluation to find problem-solving. In facilitating this controversial reasoning, a problem is needed that can lead to cognitive conflicts and metacognitive knowledge, which in this case is referred to as a controversial problem (Rosyadi, 2021). The controversial problem in this discussion is the textual mathematics problem in the form of metacognition, which causes cognitive conflict (Walida et al., 2022).

Referring to the characteristics of mathematical problems (Sudiarta, 2008), it can be seen that controversial mathematical problems have fulfilled five of the six requirements of good mathematical problems, namely significant in the field of mathematics, challenging, can stimulate students to modify ideas, provide opportunities to do various methods and provide space to create varied procedures. It is supported by articles (Subanji et al., 2021), (Swastika, A. et al., 2022) which present controversial issues that raise contradictions regarding the concept of square roots of a rank number and the concept of fractional operations. In addition, an article by (Walida et al., 2022) also mentions that disagreements in controversial math problems will lead students to challenging situations. Not only that Rosyadi (2021) also revealed that through opposition presented in the form of metacognition, students will have the opportunity to modify ideas through different methods and solutions so that it is possible for students to present varied procedures in solving their problems. However, based on the studies conducted, there is an exciting finding where controversial mathematical problems still use textual problems. It causes the meaningfulness of the problems given to students is still low (Setiawan, P. &; Sudana, 2019). So far, the application of Problem-Based Learning only uses contextual problems, such as ordinary or contextual problems that cause cognitive conflict (Yolanda, 2019). Thus, innovations are needed to develop problems that can facilitate applying Problem-Based Learning as an example of implementing controversial problems. However, controversial problems generally look the same as metacognitive problems or problems that facilitate the emergence of cognitive conflict (Alifiani & Faradiba, 2021). Therefore, to answer this urgency, a Systematic Literature Review was carried out to explore the characteristics of controversial problems by seeking comparisons between controversial issues, metacognitive problems, and problems that facilitate cognitive conflict and analyzing whether controversial problems are suitable for implementing Problem-Based Learning.

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Research Method

This study used the Systematic Literature Review (SLR) method. According to Calderon and Ruiz (in Fitriani and Prahmana, 2021), SLR is a method to identify, evaluate, and interpret several relevant studies available against the formulation of the problem or domain that is the research topic. Through the SLR method, an article can be reviewed and identified systematically through predetermined stages (Triandini et al., 2019). The object of this study was a controversial mathematical problem used to generate cognitive conflict, metacognitive knowledge, and controversial reasoning, as well as the link between the three cognitive activities in terms of the type of problem that facilitates their emergence to improve students' critical thinking. The data used in these SLRs were previously evaluated based on quality criteria questions which included: (1) is the journal accredited by Sinta, indexed by Scopus, or Web of Science?; (2) will the journal article be published within the period 2013-2023?; and (3) does the journal article present a problem used to elicit cognitive conflict, metacognitive knowledge, and controversial reasoning in students? Thus, the inclusion and exclusion criteria used in this SLR study can be seen in Table 1 below.

Table 1. Inclusion and Exclusion Criteria

Criteria	Description
Inclusion	1. The data used are journal articles for the last 10 (ten) years from 2018 to 2022. 2. Data obtained from Sinta-accredited journals, Scopus indexed, and Web of Science. 3. Data explain about problems that facilitate the emergence of cognitive conflicts, metacognitive knowledge and controversial reasoning.
Exclusion	1. Data should present issues that can facilitate cognitive conflict, metacognitive knowledge, and controversial reasoning. 2. Data should contain ways to bring up cognitive conflict, metacognitive knowledge, and controversial reasoning, such as: (a) application of problem-based learning to experimental research, and (b) cognitive conflict analysis, metacognitive knowledge, and controversial reasoning in solving mathematical problems for qualitative research

The articles in this study were collected from Google Scholar, Research Gate, SINTA, DOAJ, Scopus, and Web of Science. The key word in this study is math problems. From the results of the article search, 27 articles were obtained with the scope of discussion of mathematical problems that facilitate cognitive conflict, metacognitive knowledge, and controversial reasoning. In general, there are 3 research methods or approaches used in 27 selected articles: 2 articles classified as experimental research, 2 articles classified as literature study research, and 23 articles classified as qualitative research. Furthermore, the articles were analyzed using content analysis techniques so that the meta-analysis results related to problems that facilitate cognitive conflict, metacognitive knowledge, and controversial reasoning were found to find the potential for further study development.

Based on the objects and criteria of inclusion and exclusion described in Table 1, 27 articles were identified in this study. According to the PRISMA chart in Figure 1 below, the articles identified will go through several processes.

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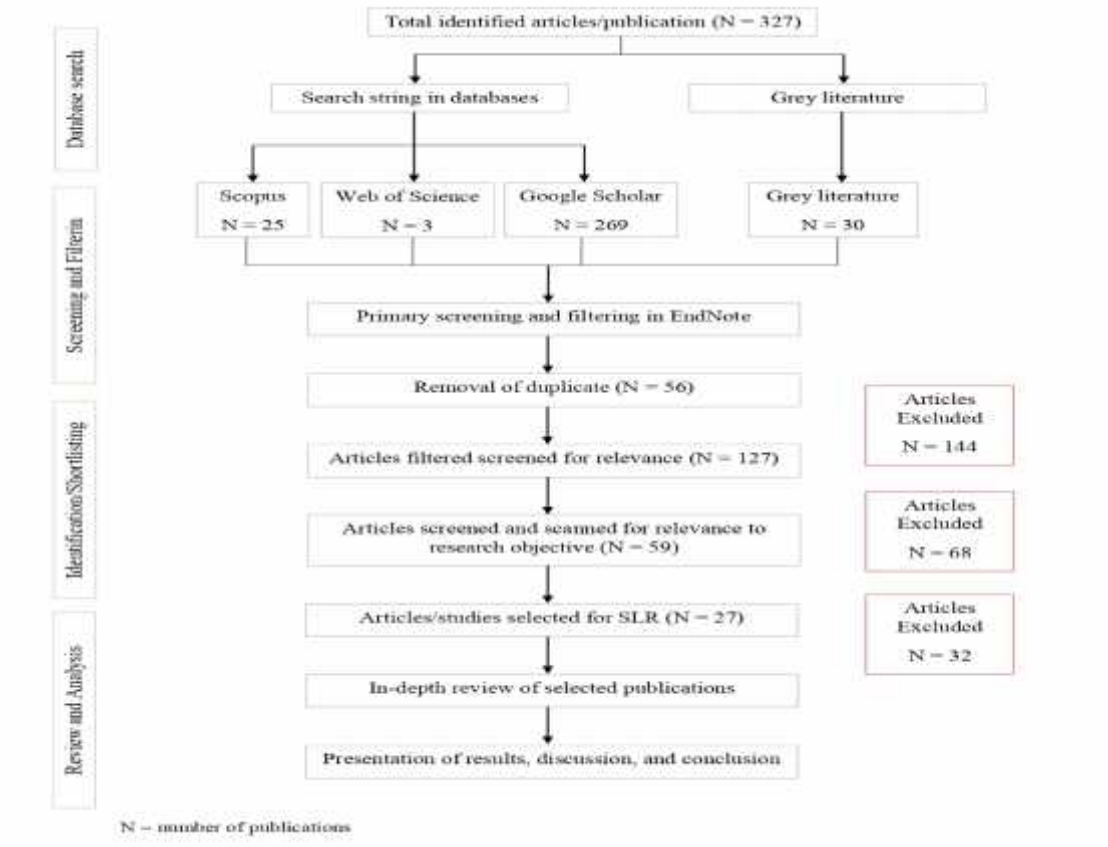

Figure 1. PRISMA Chart Article Search

Referring to article search results using the Publish or Perish (PoP) application with keywords math problems obtained 27. Then, the articles that have been obtained will be made visualizations and descriptions of bibliometric knowledge map exploration through the VosViewer application. The results are shown in Figure 2.

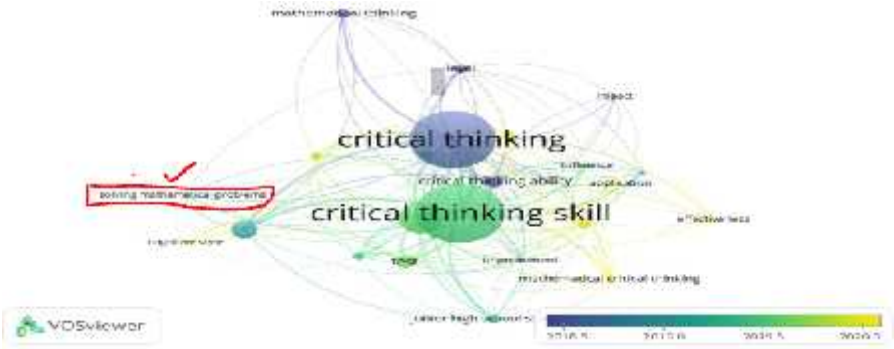

Figure 2. Research Visualization on Critical Thinking Skills

Based on Figure 2, it can be seen that the study of mathematical problems that facilitate cognitive conflict, metacognitive knowledge, and controversial reasoning is interesting to be analyzed more deeply and needs to be further studied with the potential for further research that can be done in order to improve students' mathematical critical thinking. It can be done because, for the last 10 years, the study has yet to be done. When discussing mathematics, it will not be separated from a problem that will be solved as the spirit of mathematics learning at all levels of education.

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Results and Discussion

Referring to Figure 1, 27 articles are obtained that are very relevant to describe the study of mathematical problems that facilitate cognitive conflict, metacognitive knowledge, and controversial reasoning, where the results of the meta-analysis of the findings of these articles are presented in Table 2 below.

Table 2. Meta Results of Math Problems

No.	(Author Name, Year)	Types of Research	Names and Types of Math Problems Used	Developed Mathematical Domain
1	(Rusmana, 2021)	Literature study	Cognitive problems that facilitate conflict, are not contextual, closed and in explanatory form.	Cognitive conflict, reflective thinking, and critical thinking.
2	(Ngicho, D. O. et al., 2020)	*Mixed-method*	Cognitive problems that facilitate conflict, contextual, closed and in explanatory form.	Cognitive conflict, reflective thinking, critical thinking. and troubleshooting.
3	(Sutopo, 2021)	Qualitative descriptive research	Cognitive problems that facilitate conflict, are not contextual, closed and in explanatory form.	Cognitive conflict, reflective thinking and critical thinking
4	(Lestary, R. et al., 2018)	Qualitative descriptive research	Cognitive problems that facilitate conflict, contextual, closed and in explanatory form.	Cognitive conflict, reflective thinking and critical thinking.
5	(Firmanti, P., 2022)	Qualitative descriptive research	Problems that facilitate cognitive conflicts, are not contextual, closed, and in the form of descriptions.	Cognitive conflict, reflective thinking, critical thinking. and concept understanding.
6	(Permatasari, S. W. et al., 2020)	Quasi Experiment	Problems that facilitate cognitive, contextual, closed conflicts, and in the form of descriptions.	Cognitive conflict, reflective thinking and critical thinking.
7	(Halimah et al., 2019)	Qualitative descriptive research	Cognitive problems that facilitate conflict, contextual, closed, and in the form of descriptions	Cognitive conflict, reflective thinking and critical thinking.
8	(Lestary, R. & Rum, A.M., 2022)	Qualitative descriptive research	Cognitive problems that facilitate conflict, contextual, closed and in explanatory form.	Cognitive conflict, reflective thinking and critical thinking.
9	(Adnyani, 2020)	Qualitative descriptive research	Cognitive problems that facilitate conflict, contextual, closed and in explanatory form	Cognitive conflict, reflective thinking and critical thinking..
10	(Randi, P. et al., 2019)	Qualitative descriptive research	Cognitive problems that facilitate conflict, contextual, closed and in explanatory form.	Cognitive conflict, reflective thinking, critical thinking. and troubleshooting.
11	(Murni, A. et al., 2019)	Literature study	Metacognitive problems, do not facilitate cognitive conflicts, contextual, closed, and in the form of descriptions	Metacognitive knowledge and critical thinking.
12	(Saputra, N. & Andriyani, R., 2018)	Qualitative descriptive research	Metacognitive problems, do not facilitate cognitive conflicts, contextual, closed, and in the form of descriptions.	Metacognitive knowledge, critical thinking, and problem solving.
13	(Mulbar, U. et al., 2021)	Qualitative descriptive research	Metacognitive problems, do not facilitate cognitive conflicts, contextual, closed, and in the form of descriptions.	Metacognitive knowledge and critical thinking.

No.	(Author Name, Year)	Types of Research	Names and Types of Math Problems Used	Developed Mathematical Domain
14	(Zulfikar, 2019)	Qualitative descriptive research	Metacognitive problems, do not facilitate cognitive conflicts, contextual, closed, and in the form of descriptions.	Metacognitive knowledge and critical thinking.
15	(Syafrudin, A., 2021)	Qualitative descriptive research	Metacognitive problems, do not facilitate cognitive conflicts, contextual, closed, and in the form of descriptions.	Metacognitive knowledge, critical thinking, and problem solving.
16	(Afri, L. D. & Retno, W., 2021)	Qualitative descriptive research	Metacognitive problems, do not facilitate cognitive conflicts, contextual, closed, and in the form of descriptions	Metacognitive knowledge, critical thinking, and problem solving.
17	(Cahdriyana, R. A., 2021)	Qualitative descriptive research	Metacognitive problems, not facilitating cognitive conflict, not contextual, closed, and in the form of multiple choice.	Metacognitive knowledge and critical thinking.
18	(Daher, W. et al., 2018)	Qualitative descriptive research	Metacognitive problems, do not facilitate cognitive conflicts, contextual, closed, and in the form of descriptions.	Metacognitive knowledge and critical thinking.
19	(Alifiani & Faradiba, S. S., 2021)	Qualitative descriptive research	Metacognitive problems, do not facilitate cognitive conflicts, contextual, closed, and in the form of descriptions.	Metacognitive knowledge and critical thinking.
20	(Izzati, L. R. & Mahmudi, A., 2018)	Qualitative descriptive research	Metacognitive problems, not facilitating cognitive, contextual, closed conflicts, and in explanatory form.	Metacognitive knowledge and critical thinking.
21	(Subanji et al., 2021)	Qualitative descriptive research	Mathematical problems are controversial, with types of problems that facilitate cognitive conflicts, metacognitive problems, are not contextual, closed, and in the form of descriptions.	Controversial reasoning, cognitive conflict, metacognitive knowledge, critical thinking, and reflective thinking.
22	(Swastika, A. et al., 2022)	Qualitative descriptive research	Mathematical problems are controversial, with types of problems that facilitate cognitive conflicts, metacognitive problems, are not contextual, closed, and in the form of descriptions.	Controversial reasoning, cognitive conflict, metacognitive knowledge, critical thinking, reflective thinking, and problem solving.
23	(Rosyadi et al., 2021)	Qualitative descriptive research	Mathematical problems are controversial, with types of problems that facilitate cognitive conflicts, metacognitive problems, are not contextual, closed, and in the form of descriptions..	Controversial reasoning, cognitive conflict, metacognitive knowledge, critical thinking, and reflective thinking.
24	(Walida, S. E. et al., 2022)	Qualitative descriptive research	Mathematical problems are controversial, with types of problems that facilitate cognitive conflicts, metacognitive	Controversial reasoning, cognitive conflict, metacognitive

No.	(Author Name, Year)	Types of Research	Names and Types of Math Problems Used	Developed Mathematical Domain
			problems, are not contextual, closed, and in the form of descriptions..	knowledge, critical thinking, and reflective thinking.
25	(Rosyadi, 2021)	Qualitative descriptive research	Mathematical problems are controversial, with types of problems that facilitate cognitive conflicts, metacognitive problems, are not contextual, closed, and in the form of descriptions.	Controversial reasoning, cognitive conflict, metacognitive knowledge, critical thinking, and reflective thinking.
26	(Rosyadi et al., 2022)	Qualitative descriptive research	Mathematical problems are controversial, with types of problems that facilitate cognitive conflicts, metacognitive problems, are not contextual, closed, and in the form of descriptions..	Controversial reasoning, cognitive conflict, metacognitive knowledge, critical thinking, and reflective thinking..
27	(Hand, M. & Levinson, R., 2012)	Qualitative descriptive research	Mathematical problems are controversial, with types of problems that facilitate cognitive conflicts, metacognitive problems, are not contextual, closed, and in the form of descriptions..	Controversial reasoning, cognitive conflict, metacognitive knowledge, critical thinking, and reflective thinking.

Based on Table 2, it can be seen that overall, the research theme deals with mathematical problems that facilitate the emergence of cognitive conflicts, metacognitive knowledge, and controversial reasoning. All of these articles were published in the last five years, between 2018 and 2022. Referring to Table 2 above, it can be seen that the trend of mathematics problem research is dominated by qualitative descriptive research. Not only that, it can also be summarized the dominant topics of discussion that appear in each article along with the potential for further research studies as in Table 3 below.

Table 3. Summary of Topics of Discussion and Opportunities for Further Study

No.	The Majority of Discussions Appear in Articles	Analysis of Implications and Limitations	Further Study Opportunities
1.	Generating students' cognitive conflicts through the type of cognitive problems that facilitate conflict, can be contextual or non-contextual, closed, and in the form of descriptions.	As many as 25% of articles use contextual problem types, and as many as 11% of articles use non-contextual problems to generate cognitive conflicts in students. The problems presented tend to be closed, but in the process, these problems can cause results that contradict the initial knowledge possessed by students. However, the use of problem types that can cause cognitive conflicts in both contextual and textual forms has not been able to optimize the development of students' metacognitive knowledge.	It requires developing and applying contextual and textual problems that can facilitate students' metacognitive knowledge. Thus, students not only experience cognitive activity through contradictions, but students can also control cognitive activity and ensure that cognitive goals have been met sequentially.
2.	Bring out metacognitive skills through metacognitive	As many as 33% of articles use contextual problem types in the form of metacognitive descriptions to bring out metacognition knowledge in students.	Efforts are needed to combine problems that facilitate the emergence of metacognitive knowledge with problems that can

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No.	The Majority of Discussions Appear in Articles	Analysis of Implications and Limitations	Further Study Opportunities
	problem types, in contextual form, are closed, and can be explanatory or multiple-choice questions.	Using this type of problem can help students connect the knowledge they already have with the new knowledge gained. However, using contextual problem types in the form of metacognitive descriptions only provides space for students to develop metacognitive and reflective thinking without facilitating the development of students' critical thinking (analysis and evaluation).	cause cognitive conflicts through conflicts in problems so that learning is not only meaningful but can also facilitate the development of students' higher-order thinking skills, one of which is critical thinking.
3.	Raises controversial reasoning through controversial mathematical problems, facilitates cognitive conflicts, in the form of metacognitive problems, as well as in the form of descriptions.	As many as 25% of articles use non-contextual controversial problems as metacognitive descriptions with contradictory statements. Using this type of problem can provide cognitive conflict to students and spur students to initiate, explore, and clarify problems (controversial reasoning). However, the use of controversial problem types is still limited to problems that cause cognitive conflicts and metacognitive knowledge in textual form, so the meaningfulness of the problem by students still needs to be improved.	It takes effort to develop controversial issues in a contextual form. This is so that students can not only develop their higher-order thinking skills, but also be able to interpret the learning process that has been passed.
4.	Linkages between problems that facilitate the appearance of cognitive conflicts, knowledge of metacognition and controversial reasoning	Problems that facilitate cognitive conflict are those that lead students to obtain contradictory results but have not accommodated students' increased knowledge of metacognition. Then, problems that facilitate the emergence of metacognition knowledge are generally in the form of contextual problems in the form of descriptions that direct students to think of a thought about a problem but have not caused cognitive conflicts in students. Problems that facilitate students' controversial reasoning are unique and combine problems that can give rise to cognitive conflicts and students' metacognitive knowledge.	Further study is needed to confirm that controversial mathematical problems are a unique type of problem and are metacognitive problems that facilitate cognitive conflict.

Based on the 27 articles identified, the problems that facilitate the emergence of cognitive conflicts, metacognitive knowledge, and controversial reasoning differ. In general, problems that facilitate cognitive conflict are closed mathematical problems that can be presented both in textual and contextual form, but in the process; students experience a conflict because the problem-solving is found to be contrary to real mathematical concepts or with the knowledge that students have previously (Ngicho, D. O. et al., 2020), (Sutopo, 2021). So it can be concluded that cognitive conflict is not a problem but a situation that occurs in students when there is no balance between previously owned information and information obtained in learning activities (Lestary R. et al., 2018), (Randi P. et al., 2019), (Firmanti, P., 2022). The emergence of cognitive conflicts can accustom students to face unwanted problems, provide

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challenges for students, and strengthen their mathematical knowledge and skills (Adnyani, 2020), (Permatasari et al. et al., 2020), (Halimah et al., 2019). Although it has been able to train students' reflective thinking skills through existing oppositions, this problem still cannot lead students to have metacognitive knowledge. Therefore, it is necessary to provide contextual problems that can give rise to representative thinking to facilitate the emergence of metacognitive knowledge in students (Alifiani &; Faradiba, 2021).

Unlike the problems used to facilitate cognitive conflict, the problems that facilitate the majority of metacognitive knowledge are contextual closed mathematical problems (Saputra, N. &; Andriyani, R., 2018), (Izzati, L. R. &; Mahmudi, A., 2018), (Mulbar, U. et al., 2021). The use of contextual problems is in accordance with the concept of metacognitive knowledge that accommodates declarative knowledge, procedural knowledge, and conditional knowledge (Murni, A. et al., 2019), (Zulfikar, 2019) (Alifiani &; Faradiba, 2021). The application of contextual problems can also lead students to solve problems by planning, exploring, and evaluating problem-solving carried out so that metacognitive knowledge possessed by students can be easily measured (Syafrudin, A., 2021). In line with this opinion, contextual problems can give rise to representative thinking of students where this mindset is the focus of the metacognitive approach (Daher, W. et al., 2018), (Cahdriyana, R. A., 2021). Not only that, the use of contextual problems in the article can increase the meaningfulness of learning activities carried out by students (Ani, S. I. &; Abdul, H. R., 2020). However, the metacognitive contextual type of problem still does not provide a conflict to students through conflicts that can be generated in the form of problems. Therefore, it is necessary to provide controversial problems that can accommodate cognitive conflicts in students (Rosyadi et al., 2021).

According to Swastika A. et al. (2022), in facilitating controversial reasoning, the articles use controversial mathematical problems that are closed and not contextual. The application of controversial problems becomes a middle ground between problems that facilitate cognitive conflicts and metacognitive knowledge because controversial problems present conflicts that cause cognitive conflicts while being presented in a form that can facilitate declarative, procedural, and conditional knowledge in accordance with the concept of metacognitive approaches (Rosyadi et al., 2021), (Swastika, A. et al., 2022). According to (Walida et al., 2022), controversial math problems can accommodate two important aspects of critical thinking, namely cognitive conflict, and metacognition strategies. Therefore, it can be said that controversial mathematical problems can be a unique solution to support the application of Problem-Based Learning (PBL) in an effort to improve students' critical thinking. In addition to facilitating the development of student's critical thinking, the application of controversial mathematical problems can also be a means to develop students' controversial reasoning. (Subanji et al., 2021) stated that students are said to have controversial reasoning if they succeed in meeting the stages of problem initiation, exploration, and clarification. Furthermore, Figure 3 is an example of a controversial mathematical problem that facilitates cognitive conflict and is metacognitively designed in PBL to improve students' mathematical critical thinking. According to references from previous articles, the controversial issues can be seen as follows (Swastika et al., 2022).

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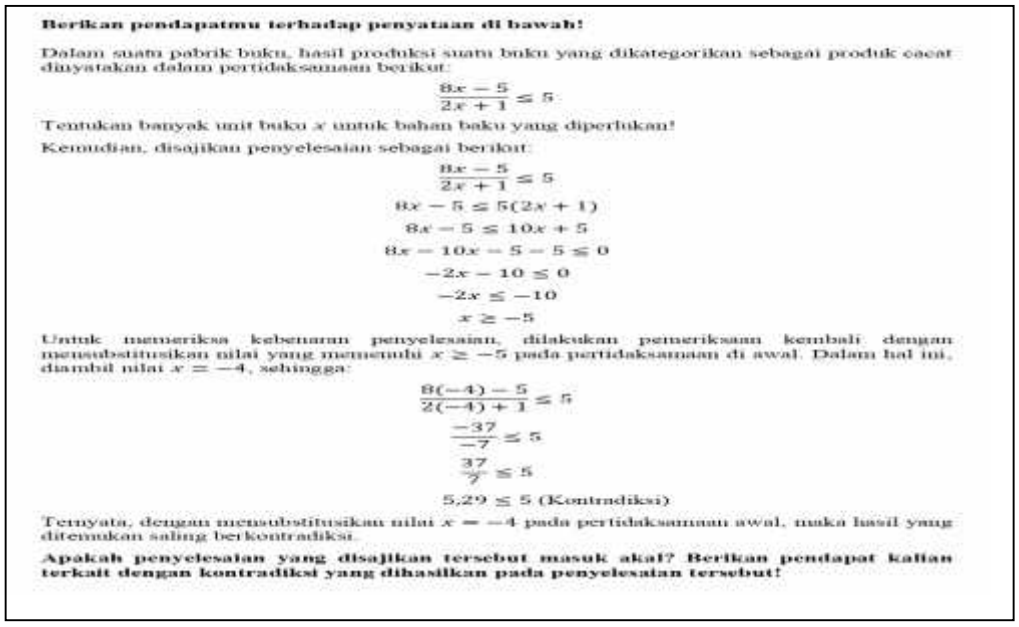

Berikan pendapatmu terhadap penyataan di bawah!

Dalam suatu pabrik buku, hasil produksi suatu buku yang dikategorikan sebagai produk cacat dinyatakan dalam pertidaksamaan berikut:

$$\frac{8x-5}{2x+1} \leq 5$$

Tentukan banyak unit buku x untuk bahan baku yang diperlukan!

Kemudian, disajikan penyelesaian sebagai berikut:

$$\frac{8x-5}{2x+1} \leq 5$$
$$8x-5 \leq 5(2x+1)$$
$$8x-5 \leq 10x+5$$
$$8x-10x-5-5 \leq 0$$
$$-2x-10 \leq 0$$
$$-2x \leq -10$$
$$x \geq -5$$

Untuk memeriksa kebenaran penyelesaian, dilakukan pemeriksaan kembali dengan mensubstitusikan nilai yang memenuhi $x \geq -5$ pada pertidaksamaan di awal. Dalam hal ini, diambil nilai $x = -4$, sehingga:

$$\frac{8(-4)-5}{2(-4)+1} \leq 5$$
$$\frac{-37}{-7} \leq 5$$
$$\frac{37}{7} \leq 5$$
$$5{,}29 \leq 5 \text{ (Kontradiksi)}$$

Ternyata, dengan mensubstitusikan nilai $x = -4$ pada pertidaksamaan awal, maka hasil yang ditemukan saling berkontradiksi.

Apakah penyelesaian yang disajikan tersebut masuk akal? Berikan pendapat kalian terkait dengan kontradiksi yang dihasilkan pada penyelesaian tersebut!

Figure 3. Controversial Issues that can Facilitate PBL

The author (Susilo et al., 2020) sees that the controversial mathematics issues above have indeed facilitated cognitive conflicts and metacognitive reasoning in students. However, according to the author's (Aini et al., n.d.) analysis, if it is related to the concept of Problem-Based Learning (PBL), the problem is still not contextual, and students do not have opportunities to think creatively and critically from their various perspectives. In accordance with the points of Problem-Based Learning (PBL), the problems used are generally problems related to everyday life (contextual). They are open-ended so that students can further explore their thinking about certain mathematical concepts (Yolanda, 2019), (Ramadhani et al., 2020). Thus, the authors view that the controversial issue to be appropriate in facilitating PBL should be able to facilitate cognitive conflict, designed metacognition, contextual, and in the form of an open-ended problem. As an example, the problem with the circle concept is taken when someone wants to change car wheels using the desired design. However, if it is adjusted to the car, it turns out it is unsuitable because the size is too big. Based on this condition, a problem can be presented which asks about how students can think in order to be able to help that person using the wheel design but still in the car. Through this example problem, students can express their opinions about the circle concept. Therefore, the authors view that to make mathematics controversial issues capable of facilitating PBL, it must not only be able to facilitate cognitive and metacognitive conflicts but also be contextual and open (Ahdhianto et al., 2020).

Speaking of problems, according to Sudiarta (2008), a good math problem is a qualified math problem: (1) significant designed problems in the field of mathematics; (2) the context of the problem is simulated in the real world; (3) problems are conditioned in interesting, varied, and challenging situations; (4) can stimulate students to modify ideas, conduct analysis, synthesis, and evaluate; (5) designed to provide opportunities for students to make various discoveries, methods, and solutions; (6) provide possibilities for students to create other situations, trying different principles and procedures within the same mathematical structure. Referring to these conditions, controversial mathematical problems have fulfilled five of the six requirements for good math problems, namely significant in the field of mathematics, challenging, can stimulate students to modify ideas, provide

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opportunities to do various methods and provide space to create varied procedures. It is supported by articles (Subanji et al., 2021), (Swastika A. et al., 2022).

The results of the Systematic Literature Review (SLR) conducted have relevance in line with the results of the Systematic Literature Review (SLR) by (Pertiwi, P. D. et al., 2022). These two studies show that applying problem provision in metacognitive form suits the application of Problem-Based Learning (PBL). In addition, the findings in this article are also in line with the results of the Systematic Literature Review (SLR) by (Suryawan et al., 2022), which found that controversial mathematical problems that contain cognitive and metacognitive conflicts can support the application of Problem-Based Learning (PBL) as a means of developing students' critical thinking. Compared with the relevant Systematic Literature Review, comparisons were made with research results by (Sukaisih et al., 2020). Compared with the relevant Systematic Literature Review, comparisons were made with research results by (Sukaisih et al., 2020).

Conclusion

Based on the Systematic Literature Review, the research concluded that: (1) mathematical problems that facilitate cognitive conflict, metacognitive knowledge, and controversial reasoning have differences from each other, (2) controversial mathematical problems are suitable to support the application of Problem-Based Learning as an effort to develop students' critical thinking; (3) controversial mathematical problems correspond to the characteristics of mathematical problems designed to be significant in mathematical problems, challenging, allow students to provide ideas and explore varied procedures according to mathematical structures; (4) Controversial issues are unique issues that can facilitate controversial reasoning where they are metacognitive problems that can give rise to cognitive conflicts.

Recommendation

Based on this Systematic Literature Review, the authors recommend that teachers implement controversial problems in learning activities as one of the problem innovations in implementing Problem-Based Learning. Moreover, referring to a comprehensive description of the mathematical problem, it can be recommended to study further to emphasize that controversial problems are metacognitive problems that can cause cognitive conflicts. It is intended so that controversial problems can be one of the solutions to realize mathematics learning that can develop students' higher-order thinking skills and be meaningful for students.

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