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Challenges of Indonesian elementary school mathematics teachers in integrating critical thinking into the classroom

Novy Trisnani[1*], Heri Retnawati[2], Wuri Wuryandani[1]

[1]Educational and Psychology Department, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
[2]Research and Evaluation Education Department, Universitas Negeri Yogyakarta, Yogyakarta, Indonesia
*Correspondence: novytrisnani.2022@student.uny.ac.id

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Abstract

This study addresses the pressing need to develop critical thinking skills in young learners, which is essential for 21st-century education. Focusing on Indonesian elementary school mathematics teachers, this research provides new insights into the specific challenges they encounter a context that has been underexplored in the existing literature. The primary objective of this study is to identify the barriers these teachers face when integrating critical thinking skills into their mathematics instruction. Utilizing a qualitative approach, the research employs open-ended online surveys, allowing participants to respond to their own words rather than selecting from predefined options. Convenience sampling was used to recruit participants, resulting in a sample of 114 teachers from ten provinces across Indonesia. Data from the surveys were analyzed thematically and inductively using constant comparative methods. The analysis identified that the major obstacles to integrating critical thinking skills into mathematics education were limitations related to time and resources (accounting for 71.34% of identified barriers), along with deficiencies in pedagogical knowledge, confidence, and skepticism about the expected outcomes. The findings of this study offer valuable insights into the considerations necessary for successfully incorporating critical thinking skills into elementary mathematics instruction and highlight the potential for enhancing teacher effectiveness in this area.

Keywords: Challenges, Critical Thinking Skills, Elementary School, Integration, Math Teacher

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The advancement of cognitive abilities and the enhancement of critical thinking skills represent pivotal objectives within the educational and learning paradigms of contemporary schools (Hanzalah & Sihes, 2021). Numerous scholars (e.g., Dwyer et al., 2014; Ennis, 1993; Khalid et al., 2021; Larsson, 2017; Roohr & Burkander, 2020) have posited that critical thinking has emerged as a principal goal of education and a fundamental metric for assessing the quality of student learning. Moreover, critical thinking extends beyond academic settings, proving essential in professional environments, effective communication, and the proficient use of technology.

Mathematics, as a fundamental subject in elementary education, holds significant potential for the integration and development of critical thinking skills among students. Engaging in mathematical problem-solving facilitates the cultivation of logical, analytical, and critical thinking abilities. The promotion of critical thinking within mathematics education is widely recognized as a global educational goal. Empirical

research underscores a strong emphasis on advancing critical thinking skills through diverse methodologies and approaches (Khusna et al., 2024; Lestari et al., 2023). Encouraging students to engage in critical thinking within the context of mathematics not only enhances their learning experiences but also contributes significantly to the field of mathematics education (Sachdeva & Eggen, 2021; Firdaus et al., 2015; Peter, 2012). In the contemporary educational landscape, critical thinking is considered essential for students (Liu et al., 2014), a perspective also reflected in the Pancasila student profile as outlined in Indonesian educational policies (Kemendikbudristek, 2022). Consequently, the integration of critical thinking into the mathematics curriculum is imperative for fostering higher-order thinking skills among students (Widana, 2018).

The 2022 PISA results indicate a decline in international learning outcomes due to the pandemic; however, Indonesia's ranking improved by 5-6 positions compared to 2018, reflecting the resilience of its education system in addressing learning losses (Kemdikbud, 2023). Despite this ranking increase, Indonesia's PISA scores have remained relatively stable within the same range for the past two decades (OECD, 2023), suggesting that there has been no substantial enhancement in the quality of education aimed at improving students' critical thinking skills. Additionally, average mathematics scores have decreased relative to 2018. According to data from the Program for International Student Assessment (PISA) (OECD, 2023), Indonesian students attained a mathematics score of 366 points in 2022, a decline from the results of the 2015-2018 assessments. This score remains significantly below the OECD average, which ranges from 465 to 475 points. Furthermore, the average performance of Indonesian students in mathematics, reading, and science continues to fall below the OECD average. Specifically, only 18% of Indonesian students reach at least level 2 proficiency in mathematics, in contrast to the OECD average of 69%. Consequently, the majority of Indonesian students perform at level 1a, indicating that they can address mathematical problems involving simple contexts with clearly defined parameters and complete information. However, students at this level struggle to apply critical and creative thinking to solve more complex problems. Nonetheless, Indonesia retains potential for improvement in critical thinking skills due to its existing capacity for development.

Elementary school mathematics teachers encounter various challenges when attempting to integrate critical thinking skills into their instruction (Begum, 2020; Benedicto & Andrade, 2022). The barriers to incorporating critical thinking into teaching are complex and multifaceted. These challenges include a lack of knowledge about critical thinking among educators, student disinterest, and an educational system that does not emphasize critical thinking as a priority (Eze et al., 2022). Additional factors contributing to these difficulties encompass community influences, educational backgrounds, social class, parental involvement, classroom environment, and teachers' perceptions (Laabidi, 2019). Moreover, challenges related to educational culture, language barriers, varying interpretations of critical thinking, differing beliefs and knowledge, and educators' attitudes towards critical thinking have been identified as obstacles to its development (Zlamal et al., 2022). Incorporating critical thinking into education also faces challenges related to the learning environment, available resources, teacher guidance, learning styles, problem-solving approaches, task activities, assessment methods, and opportunities for reflection (Chen, 2018).

Barriers to the integration of critical thinking skills into educational practices are multifaceted and necessitate collaborative efforts for resolution. Over time, various methodologies and approaches have been developed to enhance critical thinking skills within mathematics education. These initiatives have included teacher training programs, curriculum development, and the establishment of professional learning communities to support educators (Benedicto & Andrade, 2022; Brendefur et al., 2013; Graham

& Fennell, 2010; Suryawan et al., 2023). Research has underscored the necessity of addressing barriers to integrating critical thinking into the classroom, such as inadequate teacher knowledge, student disinterest, and systemic issues within the education system (Knight & Robinson, 2019; Schmaltz et al., 2017; Sellars et al., 2018; Yuan & Liao, 2023). However, previous research often overlooks the specific challenges posed by geographical diversity and infrastructure limitations in countries like Indonesia.

Despite extensive research on the barriers to integrating critical thinking skills, there remains a need for a more in-depth exploration of how specific conditions influence the application of critical thinking in elementary mathematics education. Indonesia's unique geographical conditions comprising thousands of islands with diverse topographies and varying levels of infrastructure availability present distinctive challenges for its education system, particularly in the integration of critical thinking skills into elementary school mathematics education. This research is pivotal in elucidating these barriers and supports collaborative efforts to develop a more inclusive, responsive, and adaptive education system. Successful integration of critical thinking skills in mathematics education is expected to significantly enhance educational quality and better equip students to confront future challenges. The subsequent section will examine the various challenges faced by elementary school mathematics teachers in Indonesia in integrating critical thinking skills into their teaching practices and will explore how Indonesia's geographical diversity and infrastructure limitations contribute to these challenges.

METHODS

his study employs a qualitative descriptive research design. Qualitative descriptive is an approach that facilitates a detailed and nuanced portrayal of specific phenomena or experiences from the perspectives of the participants, making it especially advantageous for researchers who are relatively new to the field (Magilvy & Thomas, 2009). This methodology is aimed at describing and interpreting data collected during the research, thereby providing an in-depth summary of the events experienced by individuals or groups (Almario et al., 2023). This approach is particularly well-suited to the research objectives, as it enables a thorough and detailed examination of the challenges encountered by elementary school mathematics teachers in Indonesia when incorporating critical thinking skills into their instructional practices.

Sample

Convenience (opportunistic) sampling was employed, based on the availability of participants in the field. Authors 1, 2, and 3 extended invitations to teachers from schools that had adopted the Indonesian new curriculum, which includes differentiated instruction, to participate in the survey. The survey link was disseminated via Google Drive, and the survey instrument was administered through Google Forms. Participants were selected using a purposive sampling technique. The inclusion criteria for this study were: (1) teachers actively engaged in the mathematics instruction process; (2) teachers willing to participate in the study; (3) schools that have implemented the independent curriculum; and (4) schools with authorization from local authorities. Exclusion criteria included teachers unwilling to participate and those not directly involved in the instructional process. Additionally, snowball sampling was utilized to encourage teachers to invite their colleagues to complete the survey, thereby ensuring broader representation of mathematics teachers across Indonesia. This sampling method, however, limits the ability to calculate a precise response rate. Ultimately, 114 survey responses were collected from participants across 10 provinces in Indonesia. The distribution of respondents by province is detailed in Table 1.

Table 1. Distribution of teachers in every region in Indonesia

Region	Province	Number of Teachers Who Filled Out the Questionnaire
Western Indonesia	South Sumatra, Central Java, West Java, DI Yogyakarta, East Java, West Kalimantan	66
Central Indonesia	NTT, East Kalimantan, Central Kalimantan, Central Sulawesi, South Sulawesi	36
Eastern Indonesia	Maluku, Papua	12

Characteristics of Survey Participants

The demographic characteristics of the survey participants are detailed in Table 2. As illustrated, there is a higher representation of female teachers relative to male teachers across all categories, reflecting the broader trend observed in Indonesia's primary education sector, where women comprise over 70% of the teaching workforce. The survey included teachers from ten provinces. Notably, approximately 65% of the respondents reported having ten or fewer years of teaching experience.

Table 2. Demographic characteristics of survey participants (N = 114)

Characteristic	Total (N=114)
Gender	
Man	24 (21.05%)
Woman	90 (78.95%)
Classes taught	
Grades 1- 2 (6 - 8 years old)	2 (1.76%)
Grades 3 - 4 (8 - 10)	96 (84.21%)
Grades 5 - 6 (10 - 12 years old)	16 (14.03%)
Level of teaching experience (years)	
1 – 5	24 (21.05%)
6 – 10	65 (57.02%)
11 – 15	23 (20.18%)
16 – 20	2 (1.75%)
Whether training to train critical thinking skills in mathematics teaching given as part of teacher training in the independent curriculum?	
Yes	95 (83.33%)
Not	4 (3.51%)
Don't remember	15 (13.16%)
Frequency of practicing critical thinking skills in mathematics learning in a semester of current lessons	
Never	68 (59.65%)
Rarely (1 – 5 times)	22 (19.30%)
Often (> 5 times)	11 (9.65%)
Not Counting	13 (11.40%)

When asked about the frequency with which they integrate critical thinking skills into their mathematics instruction during the current academic term, nearly 82% of teachers reported either never incorporating these skills or doing so infrequently (i.e., in fewer than 5 math lessons per semester).

Additionally, none of the respondents indicated that they frequently integrated critical thinking skills into their mathematics teaching (i.e., in 5 or more lessons). Regarding their training in the application of critical thinking skills within mathematics instruction as part of their teacher education, approximately 83% of teachers reported having received such training, while 15% were unable to recall whether they had received it.

Data Collection

Data were collected through an online open survey, structured into four main sections: The first section asked participants to define critical thinking indicators and provide examples; the second section requested participants to list the first five thoughts that arose when considering the topic of 'Integration of Critical Thinking Skills in Mathematics Teaching and Learning'; the third section contained eight questions related to participants' experiences with integrating critical thinking skills; and the fourth section collected contextual information about the participants (see Table 2).

The data analyzed in this paper were obtained from responses to two specific questions within the third section of the survey: (1) 'Based on your experience, what are the primary obstacles preventing you from integrating (more) training on critical thinking skills into your mathematics instruction?' and (2) 'If you have previously integrated children's literature into your mathematics instruction, or if you have not, what factors enable or encourage you to do so?' Ethical approval for the research was obtained from the respective institutions of each of the three authors based in Indonesia.

Data Analysis

The researchers utilized a naturalistic approach to data analysis, as outlined by Lincoln and Guba (1985). This method involves several key steps: transcribing survey conversations into text, systematically reviewing field notes to identify recurring themes and patterns and interpreting these themes to extract meaningful findings (Hooper et al., 2017). This approach aims to capture the nuanced perspectives and experiences of the teachers, providing a detailed and comprehensive understanding of the challenges they encounter in integrating critical thinking skills into their mathematics instruction (Lincoln & Guba, 1985).

RESULTS AND DISCUSSION

Perceived Barriers

A total of 114 educators participated in the survey, which inquired: "Based on your experience, what are the primary barriers hindering the integration of critical thinking skills into your mathematics instruction?" This group included both educators who had never employed critical thinking skills in their mathematics classrooms and those who had some experience in doing so. Given that respondents were allowed to identify multiple obstacles, the total number of coded instances for perceived barriers (N = 164) surpassed the number of survey participants (N = 114). It is important to note that this total of 164 coding events excludes two instances where coders identified no perceived obstacles (e.g., responses indicating "None").

The thematic coding analysis identified 14 perceived barriers, which were organized into four main themes: Time Constraints, Resource Constraints, Lack of Pedagogical Knowledge and Beliefs, and Doubts about Outcome Expectations (see Table 3). The theme of Time Constraints emerged as the most significant, encompassing five categories and accounting for nearly half (45.73%) of all coded instances. Within this theme, the category "limited or lack of time to plan lessons that incorporate critical thinking

skills" was the most prominent, representing over a quarter (26.22%) of the total coded instances. This was followed by "strain on distinct learning goals" (7.93%), "challenges in integrating critical thinking with the curriculum" (5.49%), and "reduced flexibility in mathematics lesson timings and schedules" (4.27%). Additionally, some respondents indicated limited or insufficient time as a barrier without specifying its exact impact. These responses were not discarded but rather categorized under "limited or lack of time (unspecified)" as part of the moderation process, representing 1.83% of the total coded instances.

Table 3. Survey responses on perceived barriers to the integration of critical thinking skills in learning

	Category	Example Statement	Total
	Theme 1: Time constraints (45.73%)		
1.	Limited or lack of time to plan lessons that can practice critical thinking skills	"I feel tied to the dense curriculum and other school activities, so it is difficult to allocate time to understand the level of understanding and individual needs of students, making it difficult for me to put together a critical thinking lesson plan that suits each student"	26.22%
2.	Pressure on the new curriculum	"The process of differentiation that requires extra time to work with small groups of students takes a lot of time, so it can sometimes be difficult to integrate critical thinking skills due to time constraints."	7.93%
3.	Limited or lack of time (unspecified)	"Time is limited."	1.83%
4.	Less flexible maths lesson times and schedules	"Rigid and hectic schedules make it difficult to devote sufficient time to practicing critical thinking skills regularly."	4.27%
5.	Difficulty integrating critical thinking with the material to be completed (curriculum pressure)	"The demands of the curriculum and the materials that must be completed make it difficult for me to put enough emphasis on critical thinking skills in teaching mathematics."	5.49%
	Theme 2: Resource Constraints (25.61%)		
6.	Lack of diverse learning resources	"I didn't find books, interactive media, or software that fit my level of understanding, which limited me in providing challenging learning experiences and building critical thinking skills."	13.41%
7.	Lack of differentiation-adjusted critical thinking material	"I had a hard time finding examples or models of critical thinking learning that fit different levels of mathematical difficulty."	8.54%
8.	Limited facilities and classrooms	"In my school, there are many physical barriers and facilities inside, for example, small classrooms, which will limit group activities"	3.66%
	Theme 3: Lack of pedagogical knowledge and confidence (23.17%)		
9.	Limited or lack of awareness of critical thinking material for certain mathematical concepts or age groups	"I don't understand examples of good material to use for a variety of topics which can train critical thinking skills"	9.15%
10.	Limited or lack of knowledge/experience/training in critical thinking skills in differentiated mathematics learning	"I felt less confident in teaching critical thinking skills because of my lack of understanding of effective strategies and methods."	10.98%

11. Difficulty and/or fear in applying approaches that practice critical thinking skills	"I was concerned that my lack of ability to practice critical thinking skills could hinder students' progress in mastering mathematical concepts well."	3.05%
Theme 4: Doubts about outcome expectations (5.49%)		
12. High expectation demands	"I feel pressured by the high expectations to produce significant progress in students' critical thinking skills."	2.44%
13. Uncertainty in measuring progress	"I find it difficult to objectively measure the extent to which students have progressed in critical thinking skills, especially in differentiated mathematics teaching that pays attention to individual needs."	1.83%
14. Concerns about student response	"I worry about whether students will respond positively and appreciate my efforts in practicing critical thinking skills, or students may feel too pressured or unable to meet established standards."	1.22%

The second most prevalent theme was Resource Constraints, which constituted over a quarter of the total coding events on perceived barriers (25.61%). This theme is divided into three categories: Lack of Diverse Learning Resources, Lack of Critical Thinking Materials Adapted to Differentiated Learning, and Limited Facilities and Classrooms. Despite teachers' awareness of various critical thinking resources applicable to mathematics instruction, the effectiveness of these resources is significantly diminished if the schools lack the necessary materials to support and develop students' critical thinking skills.

Theme 3, Lack of Pedagogical Knowledge and Confidence, accounts for 23.17% of the perceived barriers. This theme includes three categories: Limited or Inadequate Awareness of Critical Thinking Resources for Specific Mathematical Concepts or Age Groups, Lack of Experience in Implementing Critical Thinking Skills in Mathematics Instruction, and Difficulty and/or Fear in Applying Approaches to Foster Critical Thinking Skills. Finally, the fourth and final theme, Doubts about Outcome Expectations, represents 5.49% of the perceived barriers and reflects teachers' concerns regarding the effectiveness and appropriateness of critical thinking approaches. This theme comprises three types of doubts: Demand for High Expectations (2.44%), where some teachers feel pressured to set high expectations for significant progress in students' critical thinking skills; Uncertainty in Measuring Progress (1.83%), where some teachers experience difficulty in objectively assessing students' progress in critical thinking skills, particularly in differentiated mathematics instruction that caters to individual needs; and Concerns about Student Response (1.22%), where some teachers express anxiety about students' reactions to critical thinking exercises and fear that students might feel overwhelmed or fail to meet established standards.

The three most frequently cited categories collectively account for over 50% of all coded instances regarding perceived barriers. These categories include: Limited or Insufficient Time to Plan Lessons Incorporating Critical Thinking Skills (26.22%); Limited or Inadequate Awareness of Critical Thinking Resources for Mathematical Concepts (10.98%); and Lack of Diverse Learning Resources (13.41%). Strategies to address these primary perceived barriers will be explored in the Discussion section, focusing on the development of differentiated mathematical learning models designed to foster critical thinking skills.

Perceived Support

A total of 94 out of 114 teachers responded to the survey question: "If you have previously integrated or

practiced critical thinking skills in your differentiated mathematics teaching, or if not, what factors encourage or enable you to do so?" The decrease in the number of responses to this question can be attributed to the limited opportunities teachers have within their classroom settings. As respondents were allowed to identify multiple facilitators, the total number of coded instances for perceived facilitators (N = 132) was lower than the number of survey respondents (N = 94). The thematic coding analysis revealed 13 perceived facilitators, which were organized into five themes: Aspiration to Prepare for Future Competencies, Enhancing Student Progress, Recognized Pedagogical Advantages, Simplifying Learning Processes, and the Wish to Enhance Teaching (see Table 4).

Table 4. Survey responses on perceived enablers of integration of critical thinking skills

	Category	Example statement	Sum
	Theme 1: Desire to prepare future competencies (34.85%)		
1.	Encouraged and inspired by teachers' perceptions to prepare for future competencies	"I want students to be able to adapt, think critically, and make wise decisions in complex situations"	21.21%
2.	Encouraged and inspired by teacher perceptions to provide initial provisions for students	"Preparing initial provisions for students to face a competitive future."	13.64%
	Theme 2: Optimizing student development (29.55%)		
3.	Be encouraged and inspired by teacher perceptions to help develop competencies that are important for student development	"I want the child's ability to grow"	27.27%
4.	Encouraged and inspired by key stakeholders (e.g., school leaders, mentors, colleagues, and parents)	"I feel motivated to practice critical thinking skills in differentiated mathematics teaching because it can optimize student development holistically"	2.27%
	Theme 3: Perceived pedagogical benefits (16.67%)		
5.	Encouraged and inspired by teachers' perceptions that practicing critical thinking skills in mathematics learning can help students to apply and make meaningful connections between their math learning and their daily lives	"Having critical thinking skills by students will help them solve real-life problems or everyday problems encountered"	9.85%
6.	Encouraged and inspired by teachers' perceptions to be creative and innovative educators	"I don't want to be an old-fashioned teacher, on a new approach to learning, I also apply it"	3.03%
7.	Driven and inspired by the teacher's perceptions to meet his personal preferences	"Seeing students use critical thinking skills in understanding mathematical concepts gives me satisfaction and inspiration as a teacher."	2.27%
8.	Encouraged and inspired by teachers' perceptions that critical thinking skills integrating into mathematics class helps students develop metacognitive skills	"So that students' communication and answers are more reasonable and logical"	1.52%
	Theme 4: Streamlining learning (12.88%)		
9.	Encouraged and inspired by teacher perceptions to develop students' critical thinking needs	"Students, in my experience, need critical thinking skills to solve math problems."	9.85%

10.	Encouraged and inspired by teachers' perceptions of the benefits of practicing critical thinking skills	"From my experience, practicing critical thinking skills will create a more engaging and relevant learning experience for students."	3.79%
	Theme 5: desire to improve teaching (6.06%)		
11.	Encouraged and inspired by teachers' desire to improve the quality of their teaching	"Practicing critical thinking skills in class allows me to continuously hone and improve my teaching methods.	3.03%
12.	Encouraged and inspired by teachers' desire to try new methods of math's teaching	"Want to try to find a new way to teach math concepts."	1.52%
13.	Encouraged and inspired by teachers' perceptions of service	"I would love to shape a smarter generation of the nation"	1.52%

The first theme, Aspiration to Prepare for Future Competencies, encompasses two categories, which together represent 34.85% of all coded instances of perceived facilitators, making it the most significant theme among the facilitators identified. For brevity, detailed information about these categories is provided in Table 4. Notably, the category Driven and Inspired to Prepare for Future Competencies accounts for nearly 21.21% of the total coded instances. The second category, Encouraged and Inspired to Provide Initial Provisions for Students, represents 13.64%.

The second theme, Optimizing Student Development, represents 29.55% of the perceived facilitators and includes two categories. One of these is Experiencing Motivation and Inspiration from Significant Stakeholders such as school leaders, mentors, colleagues, and parents, which contributes 2.27% to the overall coding. Themes one and two are pertinent to teachers whose primary goal is to improve their mathematics teaching. If integrating children's literature can support this objective, these teachers are likely to adopt such methods.

Theme 3, Perceived Pedagogical Benefits, comprises four categories. The first category, which represents 9.85% of all coding instances, reflects teachers feeling encouraged and inspired by the belief that integrating critical thinking skills into mathematics learning helps students apply and establish meaningful connections between their mathematical knowledge and everyday life. The second category, accounting for 3.03% of the instances, involves teachers feeling motivated by the perception of being a creative and innovative educator. The third category, representing 2.27%, describes teachers who are driven by the desire to meet their personal preferences. Lastly, 1.52% of the coding instances pertain to teachers feeling inspired by the belief that training students in critical thinking skills contributes to the development of their metacognitive abilities. In general, Themes 1, 2, and 3 are related to teachers who are primarily motivated to enhance their classroom practices. If incorporating critical thinking skills aligns with this objective, these teachers are inclined to adopt such approaches.

Theme 4, Making Learning Effective, accounts for 12.88% of all coding events related to perceived facilitators. This theme includes two main categories. The first, which makes up 9.85% of the coding instances, involves teachers feeling encouraged and inspired by their perceptions of developing students' critical thinking needs. The second category, representing 3.79%, pertains to teachers who are motivated by their views on the benefits of practicing critical thinking skills. Both categories highlight how teachers' perceptions of the effectiveness and advantages of critical thinking can act as significant facilitators in their instructional approaches.

The fifth and final theme, Motivation to Enhance Teaching, accounts for 6.06% of all coded instances of perceived facilitators and is divided into three categories. The first category, representing

3.03% of the instances, reflects teachers who feel driven and inspired by their aspiration to improve the quality of their teaching. The second category, which comprises 1.52% of the instances, involves teachers who are motivated by their inclination to experiment with new approaches to mathematics instruction. The third category, also at 1.52%, pertains to teachers who feel encouraged and inspired by a strong sense of duty. Themes 4 and 5 highlight the importance of incorporating critical thinking skills into teaching, particularly for those educators who possess the necessary knowledge. They underscore the need for developing instructional models that effectively promote critical thinking skills.

Among the perceived facilitators, the most frequently mentioned categories collectively represent over half (53.5%) of all instances. These include feeling encouraged and inspired by beliefs about preparing for future competencies (21.21%), feeling motivated to provide initial support for students (13.64%), and feeling inspired to foster competencies essential for student development (27.27%).

Discussion

In discussing the three most frequently cited themes of perceived barriers, the following observations emerge, such as Limited or Lack of Time to Plan Lessons that Incorporate Critical Thinking Skills is the most significant barrier, accounting for 26.22% of all coded instances; Limited or Lack of Awareness of Critical Thinking Materials for Mathematical Concepts, represents 10.98% of the instances; and Lack of Diverse Learning Resources, constitutes 13.41% of the perceived obstacles. These barriers collectively illustrate significant challenges faced by educators in integrating critical thinking skills into their mathematics instruction. Addressing these issues is crucial for the advancement of effective teaching practices that foster critical thinking among students.

Perceived Barrier

Time Constraints (Theme 1) encompass several specific barriers, including: Limited or lack of time to plan lessons that integrate critical thinking skills; Emphasis on meeting mathematics learning objectives; Difficulty in aligning critical thinking with the required material; and Reduced flexibility in mathematics lesson timings and schedules. These findings contrast with research by Aliakbari and Sadeghdaghighi (2013), which identified student characteristics as the primary challenges faced by teachers in integrating critical thinking skills. The issues observed in this study are linked to broader educational policy concerns in Indonesia, where the extensive administrative demands placed on teachers are seen as a significant impediment to effective teaching (Kurniawan, 2016; Rusiana, 2020). These challenges are not unique to Indonesia but are also observed in other countries, as noted by Kim (2019) and Pelletier and Sharp (2009).

To address the challenge of integrating critical thinking with the material to be completed, teachers must adopt creative and flexible approaches. Research indicates that employing imaginative and creative teaching methods can significantly enhance students' self-confidence and engagement (Biasutti et al., 2015). Providing innovative teaching materials and strategies, such as open-ended problem-solving tasks, reflective questions, and collaborative activities, can effectively foster students' creative dispositions and critical thinking skills (Sukarso et al., 2022). These approaches allow students to engage in critical thinking within the context of the subject matter being studied.

Additionally, to mitigate the impact of time constraints and inflexible mathematics lesson schedules, teachers should seek opportunities to integrate critical thinking activities within their existing teaching frameworks. Munna and Kalam (2021) suggest that teachers can maximize the use of available time by identifying and utilizing periods within the lesson schedule that allow for critical thinking activities, such as incorporating these activities into recess or other non-classroom periods. This strategy enables

teachers to make effective use of existing time and provides students with opportunities to engage in critical thinking without requiring significant changes to the current teaching schedule.

The study identified resource limitations as a significant barrier to incorporating critical thinking skills into mathematics classrooms, as highlighted in Theme 2. Specifically, teachers reported a lack of diverse learning resources, and a scarcity of critical thinking materials tailored to mathematics instruction. To address these challenges, concerted efforts are needed to develop and procure relevant educational resources. The creation of a variety of differentiated mathematics learning resources should involve collaboration among curriculum developers, educators, and mathematicians. These resources must encompass a broad range of critical thinking materials suited to a differentiated mathematics curriculum, taking into account the specific contexts and needs of primary school students (Clark-Wilson et al., 2021; Foster et al., 2021; NCTM, 2023).

Moreover, effective collaboration between teachers and learning resource developers is crucial. Teachers can offer valuable input and feedback on the types of critical thinking materials needed for differentiated mathematics learning. In response, resource developers should design and provide materials that are relevant and useful for enhancing students' critical thinking skills. Additionally, continuous professional development for teachers is essential. Training programs should focus on critical thinking teaching strategies, effective use of diverse learning resources, and the integration of critical thinking into differentiated mathematics instruction. Schools must support these initiatives by allocating appropriate budgets and resources. Furthermore, government policies should ensure the availability of critical thinking materials specifically designed for differentiated mathematics instruction in all primary schools (Golding, 2018; Marishane et al., 2015; Ouyang & Ye, 2023).

Theme 3 highlights challenges related to limited pedagogical knowledge and confidence among teachers. These challenges include a lack of awareness regarding critical thinking resources suited for specific mathematical concepts or age groups, insufficient knowledge and experience in implementing critical thinking skills in differentiated mathematics teaching, and difficulties or apprehensions about applying critical thinking approaches. To address these barriers, it is crucial to implement ongoing training and professional development programs aimed at enhancing teachers' understanding of critical thinking materials relevant to various mathematical concepts and age groups. Such training should involve collaboration with mathematicians, curriculum developers, and experts in critical thinking. This will enable teachers to gain a comprehensive understanding of effective critical thinking teaching strategies and methods applicable to differentiated mathematics instruction.

Additionally, fostering collaborative and continuous development among teachers is essential. Professional learning communities can provide a platform for teachers to share knowledge, experiences, and best practices related to critical thinking in mathematics teaching. Engaging in group discussions, reflective practices, and peer observations can significantly enhance teachers' understanding and confidence in integrating critical thinking into their instruction. Finally, employing active and creative learning approaches can help overcome difficulties and fears associated with implementing critical thinking strategies. Teachers can utilize methods such as creative problem-solving to facilitate critical thinking development in students (Fahrisa & Parmin, 2022; Mar, 2021; Quaye et al., 2023; Utami et al., 2021; Vernon et al., 2016). By adopting these innovative approaches, teachers can effectively promote critical thinking skills in students while simultaneously building their own confidence in using these methods.

Theme 4, Doubts about Outcome Expectations, encompasses concerns related to the demands of high expectations, uncertainty in measuring progress, and apprehensions about student responses.

To address these barriers, it is essential for teachers to develop a realistic understanding of outcome expectations for training students' critical thinking skills. Teachers should acknowledge that the development of critical thinking is a continuous and individualized process. By clearly communicating realistic expectations to students, teachers can help alleviate the perceived pressure associated with high standards.

In addition, it is important to employ diverse and comprehensive assessment methods to evaluate progress in students' critical thinking skills. Beyond traditional written tests, teachers can incorporate formative assessments such as projects, collaborative assignments, and portfolios. These methods provide a more holistic view of students' critical thinking development and better capture the nuances of their progress (Braun et al., 2020; O'Neill & Padden, 2022). Lastly, creating a positive and supportive learning environment is crucial for addressing student concerns. Teachers should focus on building strong relationships with students, offering constructive feedback, and encouraging peer support and appreciation. By fostering a supportive classroom atmosphere and addressing individual differences, educators can reduce student anxiety related to meeting established standards and enhance their overall confidence in developing critical thinking skills.

Perceived Support

Our investigation into the three most frequently mentioned themes of perceived facilitators highlights teachers' motivations to equip students with future competencies, provide early intervention, and nurture essential skills for student development. Regarding the first theme teachers' efforts to prepare students for future competencies two key factors emerge as facilitators in the integration of critical thinking skills into differentiated mathematics instruction. Teachers are driven by the belief that critical thinking skills are crucial for students' future success, and early education is viewed as an essential step in preparing students to effectively compete at subsequent academic levels. Teachers' recognition of the importance of critical thinking for addressing complex challenges and making informed decisions in an increasingly dynamic world significantly influences the design of learning experiences that foster critical thinking. However, despite the widespread acknowledgment of the necessity of teaching critical thinking, more than half of the teachers surveyed were unable to identify specific learning situations that could promote critical thinking in mathematics classrooms (Innabi & Sheikh, 2006). Additionally, teachers who acknowledge the significance of instilling critical thinking skills from an early age tend to design learning experiences that stimulate students' analytical and reflective thinking (Pollarolo et al., 2023; van der Zanden et al., 2020). These educators understand that initiating the development of critical thinking skills at an early stage allows students to cultivate these patterns alongside their cognitive growth.

The second theme, centered on advancing student development, is motivated by teachers' objectives to foster essential competencies for student growth and is supported and encouraged by key figures, including school leaders, mentors, colleagues, and parents. According to the findings, teachers who believe that cultivating critical thinking skills can enhance students' well-being and academic achievement are more likely to incorporate these abilities into active mathematics learning and problem-solving exercises. Critical thinking skills are considered vital for students' ability to solve problems and make decisions in their daily lives (Vincent-Lancrin et al., 2019). This perspective underscores the broader impact of critical thinking skills on students' overall development, beyond mere academic success.

Teachers who are enthusiastic about incorporating or exercising critical thinking skills in mathematics instruction often draw motivation and support from influential figures such as school leaders,

mentors, colleagues, and parents. These stakeholders play a critical role in assisting teachers by providing resources, guidance, and feedback, thereby fostering an environment conducive to the development of students' critical thinking skills. Furthermore, research by Ridwan et al. (2022) suggests that teachers perceive the successful application of critical thinking skills in mathematics learning as dependent on the use of appropriate learning models, strategies, and approaches that emphasize key thinking indicators and subject matter knowledge.

The third and final theme identified as an enabler in this study relates to perceived pedagogical benefits. This theme is comprised of four categories: (1) the belief that practicing critical thinking skills in mathematics enhances students' ability to apply mathematical concepts to real-life situations, (2) the drive to be creative and innovative educators, (3) the motivation to align teaching practices with personal preferences, and (4) the perception that training in critical thinking skills helps students develop metacognitive abilities. Teachers are significantly motivated to incorporate critical thinking into mathematics instruction because they believe it enables students to make meaningful connections between mathematics and real-world scenarios. This belief underscores the importance of critical thinking in fostering a deeper understanding of information, enhancing decision-making abilities, and solving real-world problems (Halpern & Dunn, 2021; Heywood, 2018). Teachers who recognize the value of real-life contexts in mathematics education are likely to design learning experiences that encourage students to relate mathematical concepts to relevant, real-world situations and challenges, thus reinforcing the relevance and utility of mathematics in everyday life.

The second category within this theme teachers' aspirations to be creative and innovative educators is also a powerful motivator for promoting critical thinking in mathematics. Teachers' perceptions of the importance of critical thinking among students influence their classroom behavior (Yasir & Alnoori, 2020). Numerous studies have demonstrated a strong correlation between teacher creativity, innovation, and the effectiveness of classroom learning. For example, the success of classroom learning processes is significantly influenced by the creativity of the teacher (S. Kim et al., 2019). Similarly, Cremin and Barnes (2018), Machali et al. (2021), and Naz and Murad (2017) have shown that teacher creativity fosters meaningful learning environments and motivates students to develop problem-solving skills. Consequently, teachers who are inspired to be creative and innovative in their teaching will seek out a variety of strategies that stimulate students' analytical and critical thinking in mathematics. These educators believe that employing innovative teaching approaches will motivate students to think critically and creatively when solving mathematical problems.

Another enabling factor is the alignment of teaching practices with teachers' personal preferences. Teachers who integrate their interests and preferences into mathematics instruction are more likely to be engaged and motivated to develop students' critical thinking skills. These teachers recognize that connecting mathematical content with students' interests and preferences can enhance motivation and promote active engagement in learning.

Finally, the perception that practicing critical thinking in mathematics helps students develop metacognitive skills is also a significant enabler. Yasir and Al Nuri (2020) found that teachers share the perception that teaching critical thinking provides intellectual stimulation, which facilitates the development of critical thinking. Teachers who believe that fostering critical thinking improves students' understanding and reflective thinking are likely to focus on developing metacognitive skills within mathematics instruction. Many experts define critical thinking as a metacognitive process (e.g., Dwyer et al., 2014; Dwyer & Walsh, 2020; French & Rhoder, 1992; Gunawardena & Wilson, 2021; Magno, 2010;

Rivas et al., 2022). These teachers place special emphasis on helping students understand and manage their thought processes, thereby enhancing their self-awareness as mathematics learners.

In summary, the three most frequently cited themes of perceived facilitators indicate that teachers are primarily motivated by the desire to prepare students for future competencies, provide early support, and cultivate essential skills for student growth. The findings of this study offer several important implications for educational practice. First, the emphasis on preparing students for future competencies underscores the need for early development of critical thinking skills within mathematics education. Consequently, teacher training programs should prioritize the provision of strategies and concrete examples of learning situations that foster critical thinking. Second, the support and encouragement from stakeholders such as school leaders, mentors, colleagues, and parents are vital in reinforcing the integration of critical thinking in classroom instruction. The establishment of professional learning communities and collaboration among teachers can further enhance this support. Third, teachers' recognition of the pedagogical benefits of critical thinking, such as connecting mathematics learning to real-life contexts and fostering creativity and innovation, should be reflected in the design of engaging and relevant learning experiences for students. Professional development programs that focus on creativity and innovation in mathematics instruction can assist teachers in creating more meaningful learning environments. Finally, the emphasis on metacognitive skills within mathematics teaching highlights the importance of guiding students in understanding and managing their thought processes, thereby increasing their self-awareness and reflective abilities. This underscores the necessity of integrating metacognitive skills into the curriculum and daily teaching practices.

CONCLUSION

This qualitative study aimed to investigate the key perceived challenges and enablers that elementary school teachers in Indonesia encounter when integrating critical thinking skills into mathematics instruction. Through thematic analysis, 14 barriers were identified and categorized into four overarching themes, with time constraints and resource limitations constituting 71.34% of the total barriers. Similarly, 13 facilitators were identified, also organized into four themes, with the themes of Desire to Prepare Future Competencies and Optimize Student Development together representing approximately 64.4% of the perceived facilitators.

Although the analysis of open-ended survey responses provided valuable insights, it is important to acknowledge that the study did not incorporate interviews as a data collection method, which might have offered deeper insights into teachers' perspectives. Additionally, observations of mathematics lessons where critical thinking skills were integrated could have been valuable for validating the survey findings and reinforcing our conclusions.

Despite these limitations, our research highlights significant challenges that mathematics teacher educators face when attempting to integrate critical thinking into the curriculum. The findings suggest that many Indonesian teachers may currently lack the requisite knowledge, experience, and pedagogical confidence to effectively embed critical thinking skills in their mathematics teaching an approach that has been consistently supported by decades of research as beneficial. To address this, it is essential to provide teachers with research-based evidence that deepens their understanding and strengthens their beliefs about planning mathematics lessons that incorporate critical thinking. Further enhancement can be achieved by offering examples of best practices from other educators who have successfully implemented integrated approaches to teaching critical thinking skills in mathematics.

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REFERENCES

Aliakbari, M., & Sadeghdaghighi, A. (2013). Teachers' perception of the barriers to critical thinking. *Procedia - Social and Behavioral Sciences*, *70*, 1–5. https://doi.org/10.1016/j.sbspro.2013.01.031

Almario, J. I. F., Castro, R. L. G., Castro, R. L. G., Pabustan, C. J. S., David, C. J. P., Macabali, A. J., Tolentino, J. C. G., & Valenzuela, L. R. (2023). Fostering Pre-service Physical Educators' Retention of Concepts in a Professional Education Course Using Moneypoly Game. *International Journal of Multidisciplinary: Applied Business and Education Research*, *4*(9), 3366–3389. https://doi.org/10.11594/ijmaber.04.09.24

Begum, H. (2020). Impact of Mathematics Teacher's Competency on Achievement of Primary School Students. *Pakistan Social Sciences Review*, *4*(I), 699–712. https://doi.org/10.35484/pssr.2020(4-I)54

Benedicto, P. N., & Andrade, R. (2022). Problem-Based Learning Strategies and Critical Thinking Skills Among Pre-Service Teachers. *International Journal of Science, Technology, Engineering and Mathematics*, *2*(2), 1–28. https://doi.org/10.53378/352885

Biasutti, M., Hennessy, S., & de Vugt-Jansen, E. (2015). Confidence development in non-music specialist trainee primary teachers after an intensive programme. *British Journal of Music Education*, *32*(2), 143–161. https://doi.org/10.1017/S0265051714000291

Braun, H. I., Shavelson, R. J., Zlatkin-Troitschanskaia, O., & Borowiec, K. (2020). Performance assessment of critical thinking: Conceptualization, design, and implementation. *Frontiers in Education*, *5*, 156. https://doi.org/10.3389/feduc.2020.00156

Brendefur, J. L., Thiede, K., Strother, S., Bunning, K., & Peck, D. (2013). Developing Mathematical Thinking: Changing Teachers' Knowledge and Instruction. *Journal of Curriculum and Teaching*, *2*(2), 62-75. https://doi.org/10.5430/jct.v2n2p62

Chen, X. (2018). Facilitating students' critical thinking in an inclusive educational environment: Model development and testing. *International Journal of Education and Learning*, *7*(2), 21–32. https://doi.org/10.14257/ijel.2018.7.2.04

Clark-Wilson, A., Donevska-Todorova, A., Faggiano, E., Trgalová, J., & Weigand, H.-G. (2021). *Mathematics Education in the Digital Age* (A. Clark-Wilson, A. Donevska-Todorova, E. Faggiano, J. Trgalová, & H.-G. Weigand, Eds.; 1st ed.). Routledge. https://doi.org/10.4324/9781003137580

Cremin, T., & Barnes, J. (2018). Creativity and creative teaching and learning. In *Cremin, T. and Burnett, C. eds. Learning to Teach in the Primary School* (4th ed.). Routledge.

Dwyer, C. P., Hogan, M. J., & Stewart, I. (2014). An integrated critical thinking framework for the 21st century. *Thinking Skills and Creativity*, *12*, 43–52. https://doi.org/10.1016/j.tsc.2013.12.004

Dwyer, C. P., & Walsh, A. (2020). An exploratory quantitative case study of critical thinking development through adult distance learning. *Educational Technology Research and Development*, *68*(1), 17–35. https://doi.org/10.1007/s11423-019-09659-2

Ennis, R. H. (1993). Critical thinking assessment. *Theory Into Practice*, *32*(3), 179–186. https://doi.org/10.1080/00405849309543594

Eze, I. F., Iwu, C. G., & Dubihlela, J. (2022). Students' views regarding the barriers to learning critical thinking. *International Journal of Research in Business and Social Science (2147- 4478)*, *11*(4), 355–364. https://doi.org/10.20525/ijrbs.v11i4.1797

Fahrisa, N., & Parmin, P. (2022). Creative problem solving (CPS) learning to improve ability an student's critical and creative thinking on science materials. *Journal of Environmental and Science Education*, *2*(2), 98–105. https://doi.org/10.15294/jese.v2i2.55641

Firdaus, F., Kailani, I., Bakar, Md. N. Bin, & Bakry, B. (2015). Developing critical thinking skills of students in mathematics learning. *Journal of Education and Learning (EduLearn)*, *9*(3), 226–236. https://doi.org/10.11591/edulearn.v9i3.1830

Foster, C., Francome, T., Hewitt, D., & Shore, C. (2021). Principles for the design of a fully-resourced, coherent, research-informed school mathematics curriculum. *Journal of Curriculum Studies*, *53*(5), 621–641. https://doi.org/10.1080/00220272.2021.1902569

French, J. N., & Rhoder, C. (1992). *Teaching thinking skills: Theory and practice*. Garland Pub.

Golding, J. (2018). Mathematics education in the spotlight: Its purpose and some implications. *London Review of Education*, *16*(3), 460-473. https://doi.org/10.18546/LRE.16.3.08

Graham, K. J., & Fennell, F. (2010). Principles and Standards for School Mathematics and Teacher Education: Preparing and Empowering Teachers. *School Science and Mathematics*, *101*(6), 319–327. https://doi.org/10.1111/j.1949-8594.2001.tb17963.x

Gunawardena, M., & Wilson, K. (2021). Scaffolding students' critical thinking: A process not an end game. *Thinking Skills and Creativity*, *41*, 100848. https://doi.org/10.1016/j.tsc.2021.100848

Halpern, D. F., & Dunn, D. S. (2021). Critical thinking: A model of intelligence for solving real-world problems. *Journal of Intelligence*, *9*(2), 22. https://doi.org/10.3390/jintelligence9020022

Hanzalah, M. N., & Sihes, A. J. (2021). Critical thinking skills in education: A systematic literature review. *International Journal of Academic Research in Business and Social Sciences*, *11*(11), 198–201. https://doi.org/10.6007/IJARBSS/v11-i11/11529

Heywood, J. (2018). Critical thinking, decision making, and problem solving. In *Synthesis Lectures on Engineering book series (SLE)* (pp. 71–85). Springer Natur Switzerland AG. https://doi.org/10.1007/978-3-031-79382-0_6

Hooper, G. L., Allen, R. S., Payne-Foster, P., & Oliver, J. S. (2017). A Qualitative Study to Determine Barriers for Prostate Cancer Screening in Rural African-American Men. *Urologic Nursing*, *37*(6), 285. https://doi.org/10.7257/1053-816X.2017.37.6.285

Innabi, H., & Sheikh, O. El. (2006). The change in mathematics teachers' perceptions of critical thinking after 15 years of educational reform in Jordan. *Educational Studies in Mathematics*, *64*(1), 45–68. https://doi.org/10.1007/s10649-005-9017-x

Kemdikbud. (2023). *PISA 2022 dan Pemulihan Pembelajaran di Indonesia*.

Kemendikbudristek. (2022). Pedoman Penerapan Kurikulum Dalam Rangka Pemulihan Pembelajaran, Pub. L. No. 56/M/2022.

Khalid, L., Bucheerei, J., & Issah, M. (2021). Pre-Service teachers' perceptions of barriers to promoting critical thinking skills in the classroom. *SAGE Open*, *11*(3), 215824402110360. https://doi.org/10.1177/21582440211036094

Khusna, A. H., Siswono, T. Y. E., & Wijayanti, P. (2024). Research trends in critical thinking skills in mathematics: a bibliometric study. *International Journal of Evaluation and Research in Education (IJERE)*, *13*(1), 18-30. https://doi.org/10.11591/ijere.v13i1.26013

Kim, K.-N. (2019). Teachers' administrative workload crowding out instructional activities. *Asia Pacific Journal of Education*, *39*(1), 31–49. https://doi.org/10.1080/02188791.2019.1572592

Kim, S., Raza, M., & Seidman, E. (2019). Improving 21st-century teaching skills: The key to effective 21st-century learners. *Research in Comparative and International Education*, *14*(1), 99–117. https://doi.org/10.1177/1745499919829214

Knight, V., & Robinson, S. P. A. (2019). An Introduction: Establishing a Context for Critical Thinking in Teacher Education. In *Handbook of Research on Critical Thinking and Teacher Education Pedagogy* (pp. 1–14). https://doi.org/10.4018/978-1-5225-7829-1.ch001

Kurniawan, R. Y. (2016, October). Identifikasi permasalahan pendidikan di Indonesia untuk meningkatkan mutu dan profesionalisme guru. *Conference: Konvensi Nasional Pendidikan Indonesia VIII*.

Laabidi, Y. (2019). Examining teachers' perceived barriers to the integration of critical thinking in Moroccan High Schools. *ASIAN TEFL Journal of Language Teaching and Applied Linguistics*, *4*(2), 83. https://doi.org/10.21462/asiantefl.v4i2.75

Larsson, K. (2017). Understanding and teaching critical thinking-A new approach. *International Journal of Educational Research*, *84*, 32–42. https://doi.org/10.1016/j.ijer.2017.05.004

Lestari, R., Prahmana, R. C. I., Chong, M. S. F., & Shahrill, M. (2023). Developing realistic mathematics education-based worksheets for improving students' critical thinking skills. *Infinity Journal*, *12*(1), 69-84. https://doi.org/10.22460/infinity.v12i1.p69-84

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Sage Publications.

Liu, O. L., Frankel, L., & Roohr, K. C. (2014). Assessing critical thinking in higher education: Current state and directions for next-generation assessment. *ETS Research Report Series*, *2014*(1), 1–23. https://doi.org/10.1002/ets2.12009

Machali, I., Wibowo, A., Murfi, A., & Narmaditya, B. S. (2021). From teachers to students creativity? the mediating role of entrepreneurial education. *Cogent Education*, *8*(1), 1943151. https://doi.org/10.1080/2331186X.2021.1943151

Magilvy, J. K., & Thomas, E. (2009). A First Qualitative Project: Qualitative Descriptive Design for Novice Researchers. *Journal for Specialists in Pediatric Nursing*, *14*(4), 298–300. https://doi.org/10.1111/j.1744-6155.2009.00212.x

Magno, C. (2010). The role of metacognitive skills in developing critical thinking. *Metacognition and Learning*, *5*(2), 137–156. https://doi.org/10.1007/s11409-010-9054-4

Mar, G. R. (2021). *Thinking matters: Critical thinking as creative problem solving*. World Scientific. https://doi.org/10.1142/11712

Marishane, M. A., Marishane, R. N., & Mahlo, F. D. (2015). Teacher Capacity for Curriculum Differentiation in Teaching Foundation Phase Mathematics. *International Journal of Educational Sciences*, *11*(3), 253–262. https://doi.org/10.1080/09751122.2015.11890396

Munna, A. S., & Kalam, M. A. (2021). Teaching and learning process to enhance teaching effectiveness: literature review. *International Journal of Humanities and Innovation (IJHI)*, *4*(1), 1–4. https://doi.org/10.33750/ijhi.v4i1.102

Naz, F., & Murad, H. S. (2017). Innovative teaching has a positive impact on the performance of diverse students. *SAGE Open*, *7*(4), 215824401773402. https://doi.org/10.1177/2158244017734022

NCTM. (2023). Curricular Coherence and Open Educational Resources. In *NCTM*.

OECD. (2023). *PISA 2022 Results: Factsheets Indonesia*. Https://Www.Oecd.Org/Publication/Pisa-2022-Results/Country-Notes/Indonesia-C2e1ae0e/.

O'Neill, G., & Padden, L. (2022). Diversifying assessment methods: Barriers, benefits and enablers. *Innovations in Education and Teaching International*, *59*(4), 398–409. https://doi.org/10.1080/14703297.2021.1880462

Ouyang, J., & Ye, N. (2023). Differentiated Instruction: Meeting the Needs of All Learners. *Curriculum and Teaching Methodology*, *6*(11), 57-61. https://doi.org/10.23977/curtm.2023.061111

Pelletier, L. G., & Sharp, E. C. (2009). Administrative pressures and teachers' interpersonal behaviour in the classroom. *Theory and Research in Education*, *7*(2), 174–183. https://doi.org/10.1177/1477878509104322

Peter, E. E. (2012). Critical thinking: Essence for teaching mathematics and mathematics problem solving skills. *African Journal of Mathematics and Computer Science Research*, *5*(3). https://doi.org/10.5897/AJMCSR11.161

Pollarolo, E., Størksen, I., Skarstein, T. H., & Kucirkova, N. (2023). Children's critical thinking skills: Perceptions of Norwegian early childhood educators. *European Early Childhood Education Research Journal*, *31*(2), 259–271. https://doi.org/10.1080/1350293X.2022.2081349

Quaye, F. N. A., Kquofi, S., & Adom, D. (2023). Building the capacity of students in creative problem-solving and critical thinking skills: Aesthetic narrative of Ayigya Township, Ghana. *Research Journal in Advanced Humanities*, *4*(1), 1–15. https://doi.org/10.58256/rjah.v4i1.926

Ridwan, M. R., Retnawati, H., Hadi, S., & Jailani, J. (2022). Teachers' perceptions in applying mathematics critical thinking skills for middle school students: A case of phenomenology. *Anatolian Journal of Education*, *7*(1), 1–16. https://doi.org/10.29333/aje.2022.711a

Rivas, S. F., Saiz, C., & Ossa, C. (2022). Metacognitive strategies and development of critical thinking in higher education. *Frontiers in Psychology*, *13*, 913219. https://doi.org/10.3389/fpsyg.2022.913219

Roohr, K. C., & Burkander, K. (2020). Exploring critical thinking as an outcome for students enrolled in community colleges. *Community College Review*, *48*(3), 330–351. https://doi.org/10.1177/0091552120923402

Rusiana, D. A. (2020, April 3). Jokowi: Guru Sibuk Fokus Urusi Administrasi Lupa Tugas Mengajar . *Sindonews*.

Sachdeva, S., & Eggen, P.-O. (2021). Learners' Critical Thinking About Learning Mathematics. *International Electronic Journal of Mathematics Education*, *16*(3), em0644. https://doi.org/10.29333/iejme/11003

Schmaltz, R. M., Jansen, E., & Wenckowski, N. (2017). Redefining Critical Thinking: Teaching Students to Think like Scientists. *Frontiers in Psychology*, *8,* 459. https://doi.org/10.3389/fpsyg.2017.00459

Sellars, M., Fakirmohammad, R., Bui, L., Fishetti, J., Niyozov, S., Reynolds, R., Thapliyal, N., Liu-Smith, Y.-L., & Ali, N. (2018). Conversations on Critical Thinking: Can Critical Thinking Find Its Way Forward as the Skill Set and Mindset of the Century? *Education Sciences*, *8*(4), 205. https://doi.org/10.3390/educsci8040205

Sukarso, A., Artayasa, I. P., Bahri, S., & Azizah, A. (2022). Provision of Creative Teaching Materials in Improving Creative Disposition and Creative Thinking Skills of High School Students. *Jurnal Penelitian Pendidikan IPA*, *8*(6), 2728–2736. https://doi.org/10.29303/jppipa.v8i6.2514

Suryawan, I. P. P., Sudiarta, I. G. P., & Suharta, I. G. P. (2023). Students' Critical Thinking Skills in Solving Mathematical Problems: Systematic Literature Review. *Indonesian Journal of Educational Research and Review*, *6*(1), 120–133. https://doi.org/10.23887/ijerr.v6i1.56462

Utami, C., Citroresmi Prihatiningtyas, N., Rosmaiyadi, R., Husna, N., Wahyuni, R., & Mursidi, A. (2021). Ability of problem solving and critical thinking of students in learning of creative problem solving (CPS). *2021 The 6th International Conference on Information and Education Innovations*, 99–103. https://doi.org/10.1145/3470716.3470733

van der Zanden, P. J. A. C., Denessen, E., Cillessen, A. H. N., & Meijer, P. C. (2020). Fostering critical thinking skills in secondary education to prepare students for university: teacher perceptions and

practices. *Research in Post-Compulsory Education*, *25*(4), 394–419. https://doi.org/10.1080/13596748.2020.1846313

Vernon, D., Hocking, I., & Tyler, T. (2016). An evidence-based review of creative problem solving tools: A practitioner's resource. *Human Resource Development Review*, *15*(2), 230–259. https://doi.org/10.1177/1534484316641512

Vincent-Lancrin, S., González-Sancho, C., Bouckaert, M., de Luca, F., Fernández-Barrerra, M., Jacotin, G., Urgel, J., & Vidal, Q. (2019). Fostering students' creativity and critical thinking. In *Educational Research and Innovation*. OECD Publishing. https://doi.org/10.1787/62212c37-en

Widana, I. W. (2018). Higher Order Thinking Skills Assessment towards Critical Thinking on Mathematics Lesson. *International Journal of Social Sciences and Humanities (IJSSH),* *2*(1), 24-32. https://doi.org/10.29332/ijssh.v2n1.74

Yasir, A. H., & Alnoori, B. S. M. (2020). Teacher perceptions of critical thinking among students and its influence on higher education. *International Journal of Research in Science and Technology*, *10*(4), 7-19. https://doi.org/10.37648/ijrst.v10i04.002

Yuan, R., & Liao, W. (2023). Critical thinking in teacher education: where do we stand and where can we go? *Teachers and Teaching*, *29*(6), 543–552. https://doi.org/10.1080/13540602.2023.2252688

Zlamal, J., Roth Gjevjon, E., Fossum, M., Trygg Solberg, M., Steindal, S. A., Strandell-Laine, C., Hamilton Larsen, M., & Nes, A. A. G. (2022). Technology-supported guidance models stimulating the development of critical thinking in clinical practice: Mixed methods systematic review. *JMIR Nursing*, *5*(1), e37380. https://doi.org/10.2196/37380