Mathematical critical thinking ability and students' confidence in mathematical literacy

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Abstract. The progress of learning in the current era emphasizes students to have critical thinking skills, be able to implement real-world knowledge, master information technology, communicate and collaborate. One of the skills needed to achieve this goal is mathematical literacy. Therefore, it takes cognitive and affective abilities that are able to develop mathematical literacy skills, namely mathematical critical thinking ability and self-confidence. Students with good mathematical literacy skills will easily solve problems that occur in everyday life. This article examines some of the literature on mathematical critical thinking, self-confidence, and its connection to mathematical literacy.

1. Introduction
In the current 21st century, the development of technology and information has changed many things, especially the learning process. In education, schools are required to produce students who have the ability to communicate, collaborate, think critically, and solve problems, creative and innovative. This ability can be developed through the mathematics learning process. Literacy skills need to be possessed by every student because mathematical literacy has a major contribution in helping students solve problems in applying mathematics in life [1].

PISA (Program for International Student Assessment) is one of the international organizations that assess students' current mathematical literacy skills. The focus of PISA is to prioritize student skills and competencies that are obtained from school and which can be applied to their benefits in everyday life in various situations [2]. Based on the results of the 2015 PISA, Indonesia is one of the 10 countries with low literacy skills. Indonesia ranks 69 out of 76 countries that participated in the PISA survey. The literacy score of Indonesian students has an average of 375, while the international score has an average of 494 [3].

The low score of students' mathematical literacy in Indonesia is influenced by personal factors, instructional factors, and environmental factors [4]. Personal factors include students' perceptions of mathematics and students' confidence in their abilities, instructional factors include quality, intensity, and teaching methods, and environmental factors include teacher characteristics and learning media in schools.

A person is said to have mathematical literacy skills if he can analyze, reason, communicate his mathematical knowledge and skills, solve, and interpret mathematical solutions [5]. A student is said to be able to solve problems if he can use and implement previously received knowledge into new situations that he is not familiar with.
Mathematical literacy skills are important to improve because they can form the characters needed to meet the challenges of the globalization era caused by developments in science and technology. Mathematical literacy can be improved through factors contained in students, which include cognitive aspects such as numerical, intellectual, and verbal abilities and include non-cognitive aspects such as student motivation and self-confidence [6]. Students' critical thinking skills are an important cognitive aspect to be improved. Critical thinking is very necessary for someone to complete it in achieving success in life [7]. Apart from cognitive development, improving mathematical literacy skills also needs to be balanced with affective development. One of the affective developments in students is self-confidence. Confidence is an attitude that students must have in interacting well with family, friends, teachers, and of course in learning. Good self-confidence not only supports success in learning but also helps in shaping students to prepare themselves as the next generation of the nation to have the ability as individuals and citizens with good characteristics.

From the explanation above, we know that the ability of mathematical critical thinking, self-confidence, and mathematical literacy is very important to be improved in living daily lives. In this article, we will discuss the connection of mathematical critical thinking and student’s confidence in mathematical literacy.

2. Methods
Data in this article was collected using literature review method. Literature review can be in the form of combining literature, setting them up into a series of interrelated topics, and summarising them by showing the central issues [8]. In this article, the literature review method aims to collect all relevant information from the written documents such as journals and books. Documents are tracked by websites such as: googlescholar, spingerlink, Eric, and sciencedirect. This reviewed several articles and books with keywords of “mathematical critical thinking”, “self-confidence” and ”mathematical literacy”.

3. Result and discussion
3.1. Mathematical critical thinking
Critical thinking is a reflective and reasonable way of thinking that is centered on choosing what to believe or do [9]. Critical thinking according to Fatmawati [10] is thinking that uses her mind to solve a problem by first understanding the problem, expressing opinions or arguments clearly, can detect bias from various points of view, and can draw conclusions from existing problems.

Critical thinking skills are the ability to use various strategies in making decisions or actions [11][12]. This is in line with the opinion of Pezeshki [13] who say that critical thinking also involves deep reasoning abilities and consideration of what we decide.

Critical thinking skills are necessary for every individual because critical thinking can involve logical reasoning and the ability to separate facts from opinions, examine information critically with evidence before accepting or rejecting ideas and questions in connection with the problem being handled. In other words, critical thinking makes individuals think, question problems, challenge ideas, generate solutions to problems, and make smart decisions when facing challenges in life [14].

According to Gul et al. [15], the strengths of people with good critical thinking skills are have high curiosity, willing to reconsider, broad knowledge, flexible, open-minded to critical, trust in reason, honest in facing personal bias, wise in making judgments, formulate problems clearly, orderly in complex matters, diligently search for relevant information, right in the selection of criteria, focus on investigation, and persistent in the investigation.

There are six aspects of critical thinking [16]. These aspects are: 1) interpretation, the ability of individuals to interpret and express the intent of various situations, data, judgments, rules, procedures or criteria, 2) analysis, the ability of individuals to describe conclusions based on the relationship between information and concepts, with questions on the problem, 3) evaluation, the individual's ability to entrust a statement from others, 4) inference, the individual's ability to recognize the components needed to make logical conclusions by reviewing relevant information, 5) explanation, the ability of individuals to explain their reasoning when providing reasons for justifying evidence, methodology, and
logical criteria based on existing information, 6) self-regulation, individual's ability to use analysis and evaluation for validation, and to correct the results of reasoning that have been done previously with awareness to monitor cognitive activity and the elements used in these activities.

Indicators of critical thinking skills according to Ennis [9], namely: 1) provide simple explanations, namely: focusing questions, analyzing questions and asking questions, and answering questions from an explanation or statement; 2) forming basic skills, which consists of considering the credibility of the source and examining and considering an observation report; 3) concluding, which consists of taking into account the results of deductions and making and determining the value of considerations; 4) provide a further explanation, which consists of identifying terms and definitions of considerations as well as dimensions, and identifying assumptions; 5) organizing strategies and techniques, which consists of determining attitudes, actions and interacting with others.

Factors that can improve students' critical thinking skills according to Slameto [17] are supportive learning strategies such as group learning through small group discussions, using relevant contexts such as problems relating to everyday life that will be easier for students to understand, as well as assessment procedures. which requires in-depth study to motivate students to learn more meaningfully without memorizing

Several researchers have found efforts to increase critical thinking. Erdogan [18] concluded that the journal writing strategy, namely explaining the reasons, the correctness of their solutions, and their thought processes by making reflections on learning mathematics can improve students' critical thinking. Rashid [19] found that role-play strategies facilitate students to share knowledge and build shared meaning so as to improve their mathematical critical thinking skills. Retnowati [20] concluded that modules with the STEM approach can improve students' mathematical critical thinking. This module is proven to be effective and feasible in improving students' critical thinking based on the average gain value in the experimental class.

3.2. Self-confidence
Self-confidence is the ability in students to form self-believing in their ability to solve a problem at hand [21]. This is in line with Sadat [22] opinion which says that self-confidence is a positive feeling or a person's point of view about himself and his belief in his knowledge, ability, and capacity to be able to carry out tasks or solve life's problems very well.

There are several criteria that can describe or show the characteristics of a person who has self-confidence. Quoting from Nadiah [23], namely: 1) able to convey messages easily; 2) able to overcome fear and negative thoughts 3) acting independently in making decisions; 4) having a positive sense of yourself; and 5) dare to express his opinion without coercion.

Self-confidence causes students to be more courageous in showing their abilities in various situations. Students who are confident of being able to take action appropriately and effectively in various situations, despite challenges from themselves and from others [24]. Tripathy [25] states that someone who is confident in his own abilities, is able to control himself, and believes in his ability to carry out what is planned and achieved. Therefore, students with good self-confidence will tend to understand, find, and try to solve the math problems they face to get solutions. Therefore, students' confidence in mathematical abilities is very important to develop.

Several researchers have found efforts to increase self-confidence. Surya [26] concluded that a contextual learning approach makes the experience more relevant and meaningful to students build knowledge that they will apply in lifelong learning and also increase students' self-confidence. This learning model requires students to be active in every discussion. Sophia [27] found that students who are given the opportunity to solve math problems in a variety of different ways will increase their creativity in thinking and self-confidence. Kamil and Jailani [28] concluded that teachers who motivate students to be enthusiastic when studying at home and at school and learning that involves active students can increase students' confidence in mathematics.
3.3. Mathematical literacy

Mathematical literacy is the individual's ability to reason mathematically, formulate, employ, and interpret mathematics to solve problems in various real-world contexts [29]. This includes concepts, procedures, facts, and tools to describe, explain, and predict phenomena. Mathematical literacy helps individuals to understand the role that mathematics plays in the world and to make the judgments and reasoned decisions required by constructive, active, and reflective 21st-century citizens.

Someone with good mathematical literacy skills is more sensitive to mathematical concepts that are relevant to the problems they face so that they are able to use mathematical concepts to solve problems effectively [30]. This is supported by the opinion of Stacey [31] which explains that mathematical literacy is the power to use mathematical thinking in solving daily problems so that it is more mature in facing challenges in life.

Mathematical literacy is one of several cognitive abilities that are important for students to have. As a compulsory lesson from the start, mathematics is expected to be a lesson that can equip students not only the ability to use formulas in problems but also to use reasoning and analysis skills when solving daily problems. In line with that, Kuswidi [32] argues that mathematical literacy is not just a material assignment, but supports students to interpret the role and usefulness of mathematics in order to make the right decisions in everyday life.

There are seven basic competencies in mathematical literacy according to the OECD [33], namely: 1) communication, the ability to present problems and solutions to others, 2) mathematics, the ability to change real-world problems into mathematical forms through mathematical models, 3) representation, the ability to interpret various representations of mathematical objects and situations, 4) reasoning, logical thinking skills, 5) designing strategies to solve problems, 6) using language, operations, and symbols in mathematics, 7) using mathematical tools. The role of this basic component is to facilitate daily problem solving and improve math skills.

According to Li [34] there are three factors that influence students' mathematical literacy, namely: 1) individual subjective factors, namely internal factors, 2) cultural factors in learning mathematics, with appropriate mathematics learning habits, students will have a deep understanding of the ideas and enthusiasm in learning mathematics, as well as 3) educational and environmental factors.

Fery [35] found that progressing or not the location of the school had no effect in increasing students' mathematical literacy, but that the increase in students' mathematical literacy was significantly influenced by problem-based learning. Umbara [36] concluded that teachers and education policymakers must continue to examine the development of mathematical literacy, especially in the basic aspects of mathematical skills which will develop in accordance with the needs and challenges of the world that continues to grow in the future.

3.4. Mathematical critical thinking ability and student confidence in mathematical literacy

Critical thinking activities involve knowledge, consideration, communication, reasoning, proof that will guide in determining attitudes and actions taken by students to solve mathematical problems. So that when students formulate a mathematical problem, their decision making is based on considerations that have been carefully thought out [5].

Critical thinking skills also involve the ability to be logical, initiative and adaptive to change, and development of skills that lead students to have mathematical literacy skills. Students' critical thinking is closely related to students' abilities to induce, deduce, and also express arguments. Students who are accustomed to being trained to argue by paying attention to previously learned concepts will also find it easy to work on problems related to mathematical literacy [37].

In the decision-making process in critical thinking activities, a person needs self-confidence in something he will do. Self-confidence in mathematics is when students have the ability, ability, and learn mathematics well, quickly, and never give up, have confidence in their mathematical abilities, and can think realistically [38]. With strong confidence and self-confidence, students will have the ability to solve math problems.
Someone with good mathematical literacy skills certainly has a sensitivity to mathematical concepts related to the problems it faces [39]. Then the idea will develop into how to formulate the problem into a mathematical form to be finally solved. Makhmudah [29] states that with critical thinking skills students can improve their literacy skills, from understanding to making decisions. In line with that, Sukmawati [40] states that there is a significant relationship between mathematical literacy skills and the level of students' critical thinking skills as a whole. Students who have a high level of critical thinking skills will have high mathematical literacy skills. Students who are able to solve questions that require good critical thinking skills will also be able to solve problems with mathematical literacy skills well. Therefore, it is important to increase students' self-confidence and critical thinking skills so that their mathematical literacy skills will develop properly.

4. Conclusion
Based on the description above, it can be concluded that with mathematical critical thinking skills and self-confidence, students will have mathematical literacy skills to be able to solve mathematical problems in everyday life. In order for mathematical literacy skills to be achieved, it is necessary to create a learning atmosphere that supports students to improve their mathematical critical thinking skills and self-confidence. The teacher can create conditions in which students need to experience the problem-solving process in various situations and different contexts in order to use their abilities effectively. Students can develop and improve mathematical literacy skills by frequently practicing their mathematical critical thinking skills and self-confidence.

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References
[1] Genc M and Erbas A K 2019 *Int. J. Educ. Math. Sci. Technol.* 7 222–37
[2] PISA, OECD 2010 *PISA 2012 Assessment and Analytical Framework* (Paris: OECD Publishing)
[3] Safitri A, Surya E, Syahputra E and Simbolon M 2017 *Int. J. Nov. Res. Educ. Learn.* 4 93–100
[4] Lastiningsih N, Mutohir T C, Riyanto Y and Siswono T Y E 2017 *World Trans. Eng. Technol. Educ.* 15 384–9
[5] Astuti P 2018 *Pros. Sem. Nas. Mat. PRISMA* (Semarang: Universitas Negeri Semarang) pp 5–24
[6] Masjaya M and Wardoyo W 2018 *Pros. Semin. Nas. Mat. PRISMA* (Semarang: Universitas Negeri Semarang) 568–74
[7] Lee H, Parsons D, Kwon G, Kim J, Petrova K, Jeong E and Ryu H 2018 *Comput. Educ.* 97 97–115
[8] Creswell J 2017 *Research Design: Pendekatan Metode Kualitatif, Kuantitatif, dan Campuran* (Yogyakarta: Pustaka Belajar)
[9] Ennis R H 2015 *Sixth Int. Conf. Think. MIT 2013* 1–8
[10] Fatmawati H 2014 *J. Elektron. Pembelajaran Mat.* 2 899–910
[11] Afzhal M and Sugiman S 2018 *Pythagoras: J. Pendidik. Mat.* 12 173–86
[12] Azizah L I R, Sugiyanti S and Happy N 2019 *Imajiner: J. Mat. Pendidik. Mat.* 1 30–6
[13] Pezeshki M 2012 *Int. J. Educ.* 4 153–60
[14] Semil R 2006 *Hum. Soc. Sci. J.* 1 28–36
[15] Gui R, Cassum S, Ahmad A, Khan S, Saeed T and Parpio Y 2010 *Procedia - Soc. Behav. Sci.* 2 3219–25
[16] Facione P A 2013 *Critical Thinking:What It Is and Why It Counts* (California: Measured Reasons and The California Academic Press)
[17] Slameto S 2017 *J. Penelit. Hum.* 18 1–11
[18] Erdogan F 2019 *Eurasian J. Educ. Res.* 80 89–112
[19] Rashid S 2019 *Pakistan J. Soc. Sci.* 39 1265–74
[20] Retnowati S 2020 *Int. Online J. Educ. Teach.* 7 2–15
[21] Marsa B S 2014 *J. Pendidik. Mat. Unila* 2 127–31
[22] Sadat A 2016 *Didakt. J. Pendidik. Guru Sekol. Dasar, Sekol. Tinggi Kegur. Ilmu Pendidik. Subang* 2 1–11
[23] Nadiah, A and Ikhrom 2019 *J. English Linguist. Lit. Edu.* 1 1–12
[24] Burton K and Platts B 2006 *Building confidence for dummies* (West Sussex: John Wiley & Sons, Ltd)
[25] Tripathy M and Srivastava S K *Int. J. Yoga Allied Sci.* 1 33–45
[26] Surya E, Putri F A and Mukhtar 2017 *J. Math. Educ.* 8 85–94
[27] Sophia H F 2016 *J. Pendidik. Sekol. Dasar* 2 117–24
[28] Kamil N and Jailani 2018 *Adv. Soc. Sci. Educ. Hum. Res.* 326 371–6
[29] OECD Jonas Bertling & Jan Alegre 2019 *PISA 2021 Questionnaire Framework*
[30] Makhmudah S 2018 *Pros. Semin. Nas. Mat. PRISMA* (Semarang: Universitas Negeri Semarang) pp 318–25
[31] Stacey K and Turner R 2015 *Assessing Mathematical Literacy* (Australia: Springer)
[32] Kuswidi I 2015 *Al-Jabar J. Pendidik. Mat.* 6 195–202
[33] OECD 2017 *PISA for Development Assessment and Analytical Framework* (Paris: OECD Publishing)
[34] Li Y 2019 *5th Int. Conf. Edu. Tech. Manag. Hum. Sci. (ETMHS 2019)* (Xi’an: Francis Academic Press) 1765–9
[35] Fery M F, Wahyudin and Tatang H 2017 *Educ. Res. Rev.* 12 212–9
[36] Umbara U and Suryadi D 2019 *Int. J. Instr.* 12 789–806
[37] Kusumastuti R P, Rusilowati A and Nugroho S E 2019 *Unnes Phys. Educ. J.* 8 254–61
[38] Fitriani N 1994 *J. Euclid* 2 341–51
[39] Andes S A, Waluya and Rochmad 2017 *Sch. J. Pendidik. Kebud.* 7 135–42
[40] Sukmawati R 2018 *Semin. Nas. dan Pendidik. Mat.* 4 (Surakarta: Universitas Muhammadiyah Surakarta)