Analysis of The Relationship Between Critical Thinking, Refractive Thinking and Mathematical Self Efficacy on The Mathematical Literacy of Pre Service Elementary Teachers

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Abstract. The goal of this study was to examine the relationship between critical thinking, refractive thinking, and self efficacy on pre service teacher's mathematical literacy. The type of this study was ex-post facto research with a quantitative research approach. 150 Pre Service Teacher of semester 6 and 8 at primary school teacher education Program of Muhammadiyah University of Kupang. Test, observation, and questionnaire were the technique employed in this study.. All the data collected and process using SPSS 2022 version. The result would based on the partial test, simultaneous test, correlation test and lastly the analysis of the simultaneous correlation coefficient. The data analyzed by data reduction, data presentation, and conclusion drawing. All instrument used in this study were validate by two expert. The results of this study showed that there is a relationship between critical thinking, refractive thinking, self efficacy with mathematical literacy skills. The implications of this study are: First, lecturer can have the description of the state of the pre service teacher mathematical literacy skills, so that the lecturer can support and train the pre service teacher to master skills that lead to mathematical literacy skills. Second, The government must create a superior instructional approach, learning questions, learning concept that support mathematical literacy and all competencies that build mathematical literacy with the assistance of researchers.. In this study showed, enhancing mathematical literacy could start from enhancing variables or competencies that builds up mathematical literacy. And for future teaching experience lecturer can design learning circumtances that can habituate pre service teacher in solving mathematical literacy problems

Keywords : Critical Thinking, Refractive Thinking, Self Efficacy, Mathematical Literacy, Pre Service Teacher Elementary Education

BACKGROUND

Facing the challenges and competition of today's world requires human resources who have high ability to solve various problems. This ability can only be obtained through an educational process, one of which is mathematics education. Mathematics is a universal science that has an important role in various scientific disciplines that are useful in everyday life. Teachers must be aware of each pre-service teacher's traits in order to conduct attitude assessments. According to Emily (2013), teachers frequently choose not to create a written attitude assessment due to the difficulties of planning. Additionally, it is challenging to evaluate pre-service teachers' attitudes objectively. The attitudes of pre-service teachers might also be affected by daily fluctuations in mood and emotion. The learning that will best assist pre-service teachers in cultivating a positive attitude is chosen using attitude assessment rather than assessing pre-service teachers' level based on their work.

By learning mathematics a person is trained to have skills that are useful in solving problems (Syahbana, 2012). The importance of mathematics in all aspects of being a factor in mathematics is taught at every level gradually from basic education to tertiary institutions (Wardana and Lutfianto, 2018). By studying mathematics pre service teachers are prepared to have the ability to think critically, refractively and self-efficacy in order to be equipped to solve problems in society. By studying mathematics pre service teachers are prepared to have the ability to think critically, refractively and self-efficacy in order to be equipped to solve problems in society.

According to Lubis (2017) critical thinking is a rational individual who is able to think reflectively and is able to make decisions based on careful consideration. Critical thinking is also a complex process involving acceptance, mastery, data analysis, evaluation and making decisions based on evaluation results (Wiliawanto et al, 2019).In line with Anugraheni's opinion (2020) critical thinking is an organized process that involves mental activity which includes a person's ability to formulate problems, provide arguments, compile reports, provide deductions, induction, decide then carry out and interact with others to solve problems.

In addition to critical thinking, refractive thinking skills are also very much needed in solving problems as expressed by Prayitno et al (2016) refractive thinking occurs if a person is able to make decisions in determining mathematical solutions. Refractive thinking is the ability to see and identify problems through different perspectives in order to offer alternative solutions, balancing and observing problems that arise (Pagano and Roselle, 2009).

Downey (2005) utilising light as a metaphor to explain the refraction. When light strikes a medium, it undergoes refraction, which causes the light to bend towards a specific point.. Based on the metaphor, Pagano & Roselle (2006, 2009) and Medeni & Medeni (2009) claims that the reflection's ongoing critical thinking and production of new information cause the refraction to occur. Reflective thinking is therefore a symptom of thinking. Reflective thinking is the process of continuing to consider critically until a choice is made. This suggests that reflective thinking, critical thinking, and decision-making are key elements of reflective thinking. The process of refractive thinking can be illustrated in Figure 1.

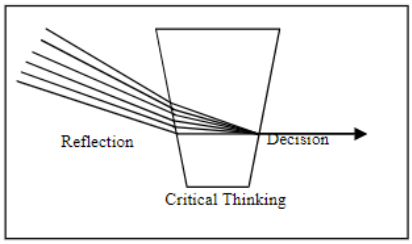

FIGURE 1. The Process Of Refractive Thinking

According to Pagano and Roselle (2006, 2009), the term "refraction" refers to the transformational knowledge that results from the use of critical analysis and problem-solving techniques to provide interpretation and conclusions of significant issues and circumstances while taking the course material and context into account. In this instance, knowledge transformation refers to a person's capacity to find creative solutions to difficulties. Refraction serves to process decision-making by taking into account potential other solutions. This demonstrates how refraction concentrates information because when reflection and critical analysis are used to arrive at alternative solutions, they are taken into account when making decisions. Be related to refraction defined by Medeni & Medeni (2009) as the learning of fresh knowledge through critical thought and reflection. The process of getting new information (decision) as a result of contemplation and critical thought is demonstrated by this. Because of this, refractive thinking in this study is a decision-making process that is perpetuated through critical thinking.

The ability that is no less important is self-efficacy. Self-efficacy is a belief in one's capacity to succeed in and finish academic tasks by the allotted target and time (Somawati, 2018). Academic self-efficacy refers to a person's level of confidence in his or her capacity to engage in various learning activities and finish tasks. Pre service teacher self-efficacy is very important to control motivation to achieve academic goals.

The three abilities above can be developed using practice methods or repeated habituation in solving mathematical problems, especially PISA questions which are significant with mathematical literacy. Mathematical literacy is the capability to formulate, employ and clarify mathematical concept in various contexts (Fathani, 2016). In line with Fathani, Anwar (2018) states that the ability of individuals to use their mathematical abilities in solving problems in everyday life effectively

Problem Of Study

In fact, In Indonesia, not all pre service teacher specially in primary education program have mathematical literacy abilities, the factors are many. But, the main problem is in teaching the pre service teacher mathematical literacy, lecturers do not have description of what state the preservice tecaher's mathematical literacy ability are, and what other competencies that have direct impact on mathematical literacy, which make more chalenging in teaching. Furthermore authors finds this is important to be followed up in a structured research.

Gap Study & Objective

According to Prayitno's (2014) research, pre-service teachers go through a number of stages of thinking skill, beginning with reflective thinking and moving on to critical thinking. Maslukha (2018) describes the characteristics of pre-service teachers in terms of their "problem-solving skills in terms of pre-service teachers' mathematical abilities, which in previous studies have not been shown in detail how pre-service teachers critical thinking, refractive thinking, and self efficacy link to mathematical literacies.. Therefore, this study will discuss it using a variety of reviews and sources. The objective of this study is to outline the phases of mathematical literacy.

METHOD

Type and Design

This study employs a correlational design, which aims to establish the nature and strength of relationships between two or more variables without attempting to manipulate any of them (Faenkel and Wallen, 2008).. The type of research used is ex-post facto research with a quantitative research approach, namely research that uses data processing in the form of numbers as a tool for analyzing and conducting research studies, especially regarding what has been researched (Kasiram, 2008). This study was conducted from May to July 2023.

This study will connects the link between critical thinking, reflactive thinking, and self efficacy to mathematical literacy.

Data and Data Sources

The population of this study is pre service teacher of semester 6 and 8 as pre service teachers at primary school teacher education Program of Muhammadiyah University of Kupang. Sample size consists of 154 pre service teachers who were randomly drawn and who had undertaken mathematics studies. The objects to be examined are critical thinking skills, reflective thinking skills, self-efficacy, and mathematical literacy.The data in this study consist results of tests, transcripts of observations, and transcript of questionnaire. In this study, pre-service instructors were given tasks to complete and were instructed to think aloud while trying to solve problems. After pre-service instructors receive compensation, research examines if they handled it correctly in order to obtain a response. Pre-service teachers will be a subject and part of the group reflecting thinking if they demonstrate reflective thinking and critical thinking in their decisions.

Data Collection Technique

- Observation
  Participatory observation and direct observation were the types of observations used in this investigation. The aspects observed from samples were critical thingking, reflective thinking, and mathematical literacy
- Tests
  Tests used in this study were designed to measure the critical thinking, reflective thinking and mathematical literacy. There were 2 types of test and each contains 25 items in the test. First test focused on critical thinking and refractive thinking problem, and the second test focused on mathematical literacy problems.
- Questionnaire

Questionnaire in this study were designed to observed the level of Mathematical Self Efficacy on pre sevice teacher

Data Validity

The face validity of the instrument was determined by one experts in test and measurement and one in primary education. The reliability of the instrument was determined using Cronbach Alpha reliability method.

Data Analysis

The data collected were analyzed using SPSS program, by determined the result of partial test, simultaneous test, correlation test and lastly the analysis of the simultaneous correlation coefficient. The results of the study also show that there is a relationship between critical, refractive thinking, and self efficacy with mathematical literacy skills.

RESULT

The results in this study aim to describe the ability of pre service teacher to think critically, refractively, self efficacy level, and mathematical literacy. Furthermore it is also to find out the relationship between critical thinking, refractive thinking, and self efficacy with mathematical literacy skills of pre service teacher.

TABLE 1. Output Description of Critical Thinking, Refractive Thinking, Self Efficacy, and Mathematical Literacy

Statistik	Kemampuan Peserta Didik			
	Berpikir Kritis	Berpikir Refraktif	Self Efficacy	Literasi Matematis
N	150	150	150	150
Range	26	28	25	22
Minimum	60	67	60	63
Maximum	86	95	85	85
Sum	10950	12100	10880	11370
Mean	73.00	80.67	72.53	75.80
Std. Deviation	8.290	8.714	8.026	7.634
Variance	68.725	75.928	64.412	58.282

TABLE 2. Output Partial Test

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
Kemampuan Berpikir Kritis	.117	.069	.127	3.695	.002
Kemampuan Berpikir Refraktif	.225	.067	.252	3.353	.001
Self Efficacy	.344	.071	.362	4.819	.000

a. Dependent Variable: Kemampuan Literasi Matematis

Based on Table 2, it can be seen that the t-count results on critical thinking skills have a value of 3.695, refractive thinking of 3.353, self efficacy 4.819, which means the t-count result is bigger than the t table which is 2.576. It shows that the H0 declined and H1 accepted, there is a relationship between critical thinking skills and

mathematical literacy skills, there is a relationship between refractive thinking skills and mathematical literacy skills, and there is a relationship between self efficacy and mathematical literacy skills.

Based on the test, observations, and questionaire result, authors identified that there are some unique relations between each variable. Authors links individual tests and questionnaire result to finds connections, in special cases it shows the same pre service teacher who have low score on mathematical self efficacy can solve the mathematical literacy problem precisely in procedures and got high score. These special cases lead to interesting discussions.

DISCUSSION

The main element in mathematical literacy was conceiving problems and converting it to mathematical form. To able to do so it takes critical thinking skills. The results of the current study demonstrated a connection between logical thought patterns and the critical thinking process. After that, the capacity to comprehend the issues encountered and develop solutions (Aini et al., 2019).

The challenges with literacy were primarily evident during the process of comprehending the issue. As a result, it failed to complete the mathematizing, communication, and representation processes. The individual then completed the calculation in the wrong order. In addition to a lack of comprehension of the issue, misunderstanding the solution method led to mistakes in the mathematical literacy process. According to research by Musafir and Susiswo (2021), a number of factors contributed to mistakes made when applying strategy to solve problems. They were misunderstandings, improper techniques, clerical faults, and writing errors. Low reading skills in subjects cause misunderstandings or a lack of knowledge of problems that require solutions.

Mathematical literacy may entail using real-world situations to solve difficulties. Things involving mathematical activity are referred to as "mathematizing" in this context. Pre-service teachers are currently able to describe the basic mathematical procedures involved in transforming problems that are defined in real-world contexts into mathematical form (which includes structure, concepts, making assumptions and/or formulating models), interpreting, and evaluating mathematical results, as well as creating mathematical models about context-specific problems. To answer a mathematical literacy problem, one needs justifications and reasoning. In this regard, pre-service instructors are already familiar with the reasoning involved in deriving conclusions from an issue by connecting and elaborating on its various components. This has a connection to reflective thinking. Additionally, pre-service instructors are already capable of verifying and defending the information provided as well as the assertion or problem-solving strategyThis is supported by a study by Prayitno (2014) that shows how pre-service teachers acquire data to solve problems before arriving at a conclusion that they believe is accurate. at order to be able to claim that the subject is currently at the stage of refractive thinking.

Mathematical literacy requires the discovery of strategies to solve mathematical problems. This group of critical processes is categorised as selecting, discovering, or planning mathematically-based tactics. In this respect, pre-service teachers are able to identify issues clearly, use formulae to address them, and find solutions. This links to the stages of self efficacy of the pre service teacher.

Furthermore, This investigation made fresh discoveries. Results of respondents' tests, observations, and questionnaires provide information about their aptitude, and these findings demonstrate that: (1) subjects marhematical literacy involves critical thinking skill (2) refractive thinking term is unfamiliar amongs subjects but test result show subjects have the ability in the good level. (3) mathematical self efficacy level on subjects in special cases are not linear to mathematical literacy.

CONCLUSION

Novelty and Contribution

Based on this study, enhancing mathematical literacy could start from enhancing variables or competencies that builds up mathematical literacy. And for future teaching experience lecturer can design learning circumtances that can habituate pre service teacher in solving mathematical literacy problems

Limitation and Future Study

The current study contains a number of drawbacks. It initially has to do with the diversity of subjects. Subjects only selected from Universitas Muhammadiyah Kupang, specificly on primary education program, this made the data less diverse. Second, the research type in this study is expost facto, whichs authors only describing data, and

for further study this research is expected to be the background of development researches about mathematical literacy.

REFERENCES

1. Anugraheni, Indri. 2020. Analisis kesulitan mahasiswa dalam menumbuhkan kemampuan berpikir kritis melalui pemecahan masalah. Jurnal cendekia: jurnal pendidikan matematika, 4(1), 261-267
2. Dinni, H. N. (2018). HOTS (High Order Thinking Skills) dan Kaitannya dengan Kemampuan Literasi Matematika. PRISMA, Prosiding Seminar Nasional Matematika, 1, 170-176.
3. Downey, G. (2005). How to Guide and Facilitate Self Reflective Practice in Re-Entry Programs. Presented at CIEE Conference, Miami, FL.
4. Lubis. 2017. Pengaruh penerapan model pembelajaran pemecahan masalah pada kemampuan berpikir kritis mahasiswa. Jurnal pendidikan biologi. 6(2), 291-295.
5. Meilani, D., & Aiman, U. (2020a). Implementasi Pembelajaran Abad 21 Terhadap Hasil Belajar IPA Peserta Didik Dengan Pengendalian Motivasi Belajar. Indonesian Journal Of Primary Education, 4(1), 19–24.
6. Medeni, T.D., & Medeni, I.T. (2012). Reflection and Refraction For Knowledge Management Systems. International Journal of Ebusiness and Egovernment Studies. Vol 4, No 1, 55-64.
7. Pagano, M., & Roselle, L. (2006). Think Piece Study Abroad ISL: Connecting and Experience. Paper Prepared for the connectingknowledge and experience conference. pp: 1-5. Elon University
8. Pagao, M. dan Roselle L.Beyond. 2009. Refraction and experiental education. Frontiers: the interdisciplinary journal of study aboard. 18, (2009) h. 219
9. Prayitno, Anton, dkk. 2014. Proses Berpikir Refraktif Siswa Menyelesaikan Masalah Data Membuat Keputusan. Dalam Prosiding Seminar Nasional TEQIP, 1 Desember 2014. Malang.
10. Prayitno, A. (2015). Proses Berpikir Refraksi Siswa dalam Menyelesaikan Masalah Matematika tentang Kesamaan. Jurnal Likhitaprajna, 17(1), 25–37.
11. Prayitno, dkk. 20216. Refractive thinking with dual strategy in solving mathematic problem. IOSR-JRME, 6(3), 49-59.
12. Somawati. 2018. Peran efikasi diri terhadap kemampuan pemecahan masalah matematika. Jurnal konseling dan pendidikan, 6(1), 39-49
13. Syahbana, A. 2012. Peningkatan kemampuan berpikir kritis matematis melalui pendekatan CTL. EDUMTICA: Jurnal Pendidikan Matematika, 2(1), 45-57.
14. Wardhana dan lutfianto. 2018. Analisis kemampuan komunikasi matematis siswa ditinjau dari kemampuan matematika siswa. Jurnal pendidikan matematika vol. 6 no. 2
15. Wiliawanto, dkk. 2019. Penerapan model pembelajaran aktif question pre service teacher have untuk meningkatkan kemampuan berpikir kritis matematik siswa SMK. Jurnal cendikia: jurnal pendidikan matematika, 3(1), 139-148.