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Students' Mathematical Literacy Viewed from Cognitive Style: Systematic Literature Review

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ABSTRACT

This study aims to describe the results of research on students' mathematical literacy analyzed based on cognitive styles. This study used Systematic Literature Review (SLR) method. The sample in this study were 11 articles regarding students' mathematical literacy viewed from cognitive styles which were published in 2018 to September 2022 and were located in Indonesia. The results of this study will be reviewed based on the year of publication, level of education, research location, and to find out the description towards students' mathematical literacy viewed from cognitive style. By using the SLR method, it was found research on students' mathematical literacy viewed from cognitive styles got a lot of attention every year, most of this research was conducted at the senior high school (SMA) education level, and most of this research was carried out in the Java Island. In addition, by synthesizing the results of research on students' mathematical literacy viewed from cognitive style with the help of Atlas.ti, it was found that cognitive style influences students' characteristic in using their mathematical literacy.

Keywords: *Cognitive Style; Mathematical Literacy; SLR*

1. Introduction

Problem solving is a skill which is essential for everyone in order to create solution in life. Mathematics is the basis for problem solving, information processing, and communication which is a requirement of routine work [1]. The skill in mathematics needed as an equipment for those activities is called as mathematical literacy. Mathematical literacy becomes a big issue in education especially after the flourish of PISA (Programme for International Student Assessment). PISA is the programme measuring the ability of students who are 15 years old to use their reading, mathematics and science knowledge and skills to meet real-life challenges. According to PISA context, mathematical literacy is an individual's capacity to formulate, employ and interpret mathematics in a variety of contexts including reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomenon [2]. In addition, mathematical literacy is an ability that focuses on the use

of mathematics in life day-to-day activities that are not limited to mathematical operations [3]. Mathematical literacy can be utilized in making choices and leading a fully purposeful life [4]. Thus, mathematical literacy is not only beneficial in solving mathematical problem but also real-life problem.

Even though mathematical literacy is considered as essential skill to be had by students, many of them are still categorized in a low mathematical literacy level. Some 28% students in Indonesia reached Level 2 or higher in mathematics and about 1% of students attained at Level 5 or higher in mathematics [2]. The low achievement of mathematical literacy is because they are not accustomed to investigate situational problems, as a result will be considered to solve the problem narrow math [5].

Mathematical literacy is the capacity to apply mathematics in solving a problem in life everyday life which is closely related to thinking and the process of thinking is closely related to cognitive style [6] and thinking analysis is also related to students' cognitive style [7]. Cognitive style is a crucial element that influences students' choices in the field of academics, mainly related to learning problems, student learning behavior patterns, how students learn, students' ways of thinking, how students process information and how students solve problems [8]. Because of its definition, it means that every person certainly has different cognitive styles and thinking processes [9]. Witkin and Goodenough introduced field dependence and field independence as terms used to describe the cognitive style recommended by as a process variable, define the degree of autonomous functioning in assimilation of information from self and field [10].

Field-dependent persons have a tendency to see things as entire pattern and find it kinda tough to break all patterns down into their component pieces. They also tend to be quickly agitated and confused, which makes it difficult for them to solve problem. [11]. This means that field dependent pupil can simply be troubled by tricky element [12]. On the other hand, those who are field independent respond relatively quickly, but also make few mistakes in the process [13]. Students with field independent cognitive style have the tendency to accept and interpret the problem better than students with field dependence cognitive [14]. In addition, field independent students have higher mathematical literacy achievements in solving mathematical literacy test questions than students with field dependence cognitive style [15]-[17]. Field dependent subjects have limited analysis resulting in not meeting the aspects of mathematising abilities and at the same time field independent students do not meet the aspects of mathematical literacy skills in mathematising [18]. Based on those research results it can be assumed that both field dependent style and field independent style have different characteristics in using mathematical literacy.

Despite of the fact stated above, it is still unclear how is the description of the characteristic for each cognitive style, especially field dependent and field independent, in using mathematical literacy. Thus, further study about this matter should be conducted to synthesized all findings towards this research to find out the students' characteristic and tendency for each cognitive style in using their mathematical literacy. The study needed for this circumstance is systematic literature review (SLR) attempted to answer an unusual research issue in a transparent and reproducible way by compiling each piece of information that has been released on the subject and assessing the quality of that evidence [19].

The purpose of this study is to explain findings from research on students' mathematical literacy as it relates to their cognitive style, particularly with regard to field dependent and field independent style. The description in this study will be reviewed based on the year of publication, level of education, research locations, and synthesis result from all articles having been collected.

2. Method

Metode The method used in this research is Systematic Literature Review. Systematic review attempts to collate all empirical evidence that fits pre-specified eligibility criteria in order to answer a specific research question [20]. The purpose of this study was to compile secondary data collected from the research results of students' mathematical literacy ability viewed from field dependent and field independent cognitive style.

The procedure of this research is collecting the data, analyzing the data and drawing conclusion. The data collected is primary data having been made into articles or national journals. After collecting the data, the sorting was applied to obtain relevant articles to be analyzed in this research.

Systematic Literature Review research procedure design consists of [21]:

2.1 Develop Research Question

Through the data that was retrieved, the researcher poses the following pertinent queries:

(1) How does the description of the research findings relate to students' mathematical literacy viewed from cognitive style the term of the year of publication?
(2) How does the description of the research findings relate to students' mathematical literacy viewed from cognitive style in the term of level of education?
(3) How does the description of the research findings relate to students' mathematical literacy viewed from cognitive style in the term of research location?
(4) How is the description of students' mathematical literacy viewed from cognitive style?

2.2 Selection Criteria

For the selection criteria in this study used the following inclusion criteria:

1. Research conducted in Indonesia
2. Research conducted in 2018-October 2022
3. Research on students' mathematical literacy viewed from field dependent-independent cognitive style

At the beginning, the researcher put the inclusion criteria as stated above but for the article issued in these past 10 years. Unfortunately, from 2013-2017 the researcher can only find 1 article related to this topic. Thus, the researcher decided to collect the article from the latest 5 years. As an effect of the inclusion criteria, the population in this study are all studies on the students' mathematical literacy viewed from field dependent and field independent cognitive style having been published in varied publishers.

2.3 Developing the Search Strategy

The search process was carried out using a search engine with Google Scholar, Garuda and national journal direct URL. Search strings are needed for more specific searches and avoid filtering too large a number. Search strings in this study: ("Mathematical Literacy*" or "Mathematical Literacy*") and ("Cognitive Style*" or "Cognitive Style*" or "Mathematical Literacy Cognitive Style*" or "Mathematical Literacy Cognitive Style*" or " Field Dependent Field Independent*" or "Mathematical Literacy Field Dependent Field Independent*" or "Field Dependent Mathematical Literacy Field Independent*").

2.4 The Study Selection Process

In the study selection process, namely the process where the title and abstract of the article are examined first to determine whether the research is relevant or not [21].

2.5 Appraising the Quality of Studies

In SLR research, the data found will be evaluated based on the following quality assessment criteria questions:

1. Was research on the literature carried out in Indonesia?
2. Does the literature write down research problems that are relevant to this research?
3. Was the literature published in the period 2018-October 2022?

From each journal literature, an answer value for each question above will be given with Y (Yes) or T (No).

Based on the process above, it was obtained 11 articles became the sample in this study. The data that met the inclusion criteria were included and was analyzed and synthesized using ATLAS.ti. Descriptive quantitative data analysis was used in this study.

3. Result and Discussion

This research was conducted by analyzing 11 journals related to students' mathematical literacy based on cognitive style field dependence-independence. The first step was finding articles related to its topic. The keywords utilized to search the articles were "mathematical literacy" and "cognitive style". From the search, it was obtained 28 articles related to mathematical literacy and cognitive style. After the selection using the inclusion criteria, the number of articles decreases to 11 articles related to mathematical literacy and cognitive style field dependence-field independence during 2018-2022. These titles are found in different portals, namely eprints unm, IOP Conference Series, Kreano jurnal, SEMNAS LPPM Universitas Muhammadiyah Purwokerto, saintifika journal, Union journal, ICMSE Journal of Physics: Conference Series, Proceeding PRISMA, Edukatif journal, Proceeding of Mathematics Education National Seminar II (SNPMAT II), and Kadikma journal.

By utilizing the criteria for inclusion in all relevant studies, three moderating variables were used to further categorize all of the data. namely year of study, study level and research location.

Tabel 1. Number of studies based on criteria

	Criteria	Number of articles
Year of study	2018	1
	2019	3
	2020	1
	2021	4
	2022	2
Study Level	Elementary School	1
	Junior High School	4
	Senior High School	5
	University	1
Research Location	Sumatera	0
	Java	7
	Kalimantan	1
	Sulawesi	2
	Papua	1

From the Table 1 above it can be seen clearly that during the last 5 years, the study about students' mathematical literacy based on cognitive style field dependent and field independent was majorly conducted in 2021. The study about this topic was dominantly located in Java island and in contrast, there was no study about this matter conducted in Sumatera and Papua. Further explanation will be discussed bellow to gain more specific details which are depicted by Figure 1, Figure 2, and Figure 3.

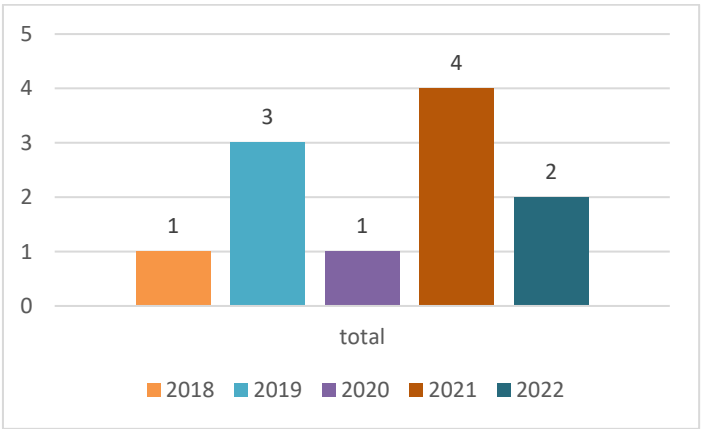

Figure 1. Study based on year of publication

From the Figure 1, it was shown that the research about students' mathematical literacy gained a lot of recognition each year due to its needs to be dug deeper in order to get more information about students' mathematical literacy viewed from cognitive style especially for those who have field dependent or field independent style. Based on Figure 1, it was known that the most publication about students' mathematical literacy was issued in 2021 with the number of articles is 4 articles and the least number of publications happened both in 2018 and 2020 with only 1 article for each.

The other criterion was analyzed based on education level. Students in each level education have different characteristic in using their mathematical literacy. The number of numerous studies conducted at various educational levels is shown in Figure 2 below.

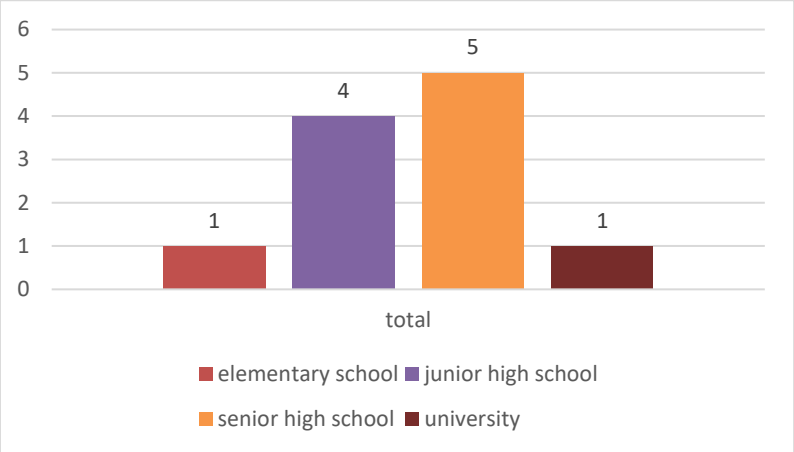

Figure 2. Study based on level of education

Figure 2 above depicts the study of students' mathematical literacy viewed from cognitive style field dependent and field independent. The highest number of its research was the study conducted in senior high school with 5 articles in total. The reason for choosing high school students as subjects is because their structure of thinking and math skills as literacy assessment subjects are growing better than that who is in junior high school students [3]. The second highest number was followed by the research carried out at junior high school which is reasonable as PISA is purposed to a 15-year-old student assessment [22].

The next criterion is analyzed based on research location to be seen in Figure 3 below which shows big difference regarding the number of researches conducted in each island in Indonesia.

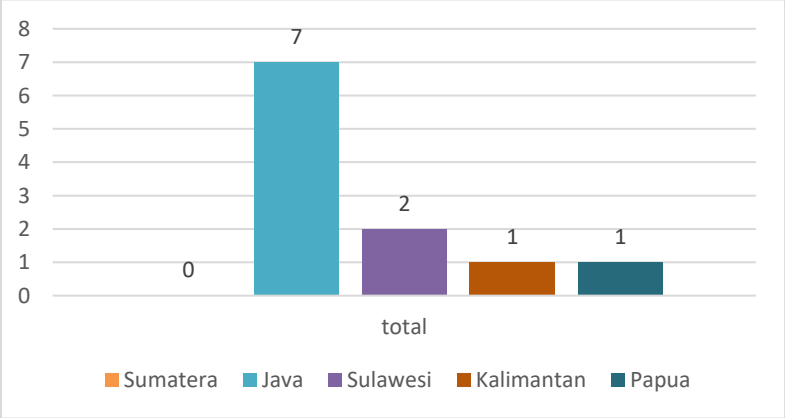

Figure 3. Study based on research location

Based on Figure 3, it was known that the most research about students' mathematical literacy was performed primarily in Java with the number of articles id 7 articles. This is consistent with the assertion the research about student's mathematical literacy widely conducted in Java [23]. This is also supported by the findings that informed the majority of the research on pupils' mathematical literacy has been done in Java, whereas there has been less of it conducted in Papua [24][25]. In addition, another similar result also stated

the majority research of students' error was conducted in Java [26]. Based on these data, it is clear that mathematical ability is rarely conducted in the other islands but Java.

The fact that there cannot be found any research about students' mathematical literacy viewed from field dependent and field independent cognitive style in Papua and Sumatera becomes an issue that needs to be solved. One of the possibilities behind this result is the use of several variables to examine students' mathematical literacy. Another possibility is mathematical literacy dominantly researched using the application of other methods [27].

From synthesizing 11 articles about students' mathematical literacy viewed from cognitive style, it can be said that students with field dependent and students with field independent have different characteristics in using their mathematical literacy. In the term of formulating the problem, students with independent cognitive style can identify issues and use their representation ability well especially using verbal representation, symbol, and make appropriate mathematical modelling. This statement is in line with the characteristic of field independent students that they are focusing on material in detail and are able to organize information independently [28]. In contrast, students with dependent style tend to have the ability in identifying the issue but sometime they have difficulty in using their representation ability in order to make mathematical model. This is in accordance to students who have field dependent cognitive style tend to accept concepts and material in general and they are rather difficult to relate the concepts in the curriculum with their own experience or prior knowledge they already have [28].

In the term of employing concepts, facts, procedures and mathematical reasoning to solve the problem, field independent students can express their answer confidently, structured, and tend to use their own language and produce varied words in expressing their argument and reasoning. Besides, they also have a good reasoning. Students with field independent have the ability to understand the complex assumptions and determine the proper and precise strategy. This is in line with field independent students show a tendency to organize information into manageable units and has a greater capacity for information storage. they also have a higher level of analysis in receiving and processing information [29]. On the other hand, field dependent students tend to explain their argument based on the words or sentences stated in the question. Furthermore, field dependent students are less able in using their representation ability and less analytic in solving mathematical problem, tend to understand the problem not in-depth since some elements of distraction are influenced. Because of these reasons, field dependent students sometimes also have difficulty in determining precise strategy to solve the problem. This result is in argument with students with field dependent cognitive style tend to accept information as it is presented or found and rely mostly on memorization [29].

Beside of formulating and employing, the other indicator of mathematical literacy is interpreting, applying, and evaluating math results. Both students with field dependent and students with field independent cognitive style can interpret mathematical solution contextually. The different between the two is the language used in explaining the interpretation. Field independent students tend to use various words and their own language to express the interpretation while field dependent students tend to use the same language as that stated in the problem.

4. Conclusion

Through the SLR method, it was found the articles of students' mathematical literacy viewed from field dependent and field independent cognitive style is still gaining a lot of attentions during these past five years. The research about this matter is widely conducted in Java island and mostly using students who are in senior high school as the sample of the research. It was also obtained that students with field dependent and field independent cognitive style have different characteristic in using their mathematical literacy. Besides, through the SLR method, it was known that field independent students are in the tendency to use their representation well and have a good reasoning in using their mathematical literacy which is in accordance to the characteristics of field independent students' theory. Furthermore, students with field independent cognitive style tend to use their own language in expressing their argument, reasoning, and interpretation, while students with field dependent cognitive style tend to be less analytic in using their mathematical literacy which is in line with the characteristics of field dependent students' theory. In addition, field dependent students tend to use the same language stated in the problem.

Further research about the external factors that cause these different characteristics should be conducted in order to gain precise insight about it and help both teachers and students to find the best learning strategy to develop students' mathematical literacy

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