

MATHEMATICAL LITERACY PROFICIENCY DEVELOPMENT BASED ON CONTENT, CONTEXT, AND PROCESS

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Abstract

One of warm issue in education is literacy proficiency. The literacy proficiency development is one of concern in education generally, so is in mathematics education as well. This research aims to describe the growth of junior high school students' mathematical literacy proficiency in Yogyakarta Special Region, Indonesia. Three mathematical literacy proficiency aspects were examined in the study, namely content, process and context. It was an exploratory descriptive research with cross-sectional type research design. The population was junior high school students ranging between 13 and 16 years old were selected using the combination of stratified and the cluster random sampling technique. A test consisting of 30 items, were adopted from the existing PISA test items, used to collect the data in the study. The main data analysis was conducted by estimating students' ability through the item-response theory approach. The results showed that the mathematical literacy proficiency of the students in Yogyakarta based on content, context, and process, still low. Some strategies that can be taken to improve mathematical literacy proficiency of the student discussed.

Key words: mathematics, literacy proficiency, content, context, process.

Introduction

Advances in Information and Communication Technology (ICT) have introduced new changes and challenges. Education is expected to prepare individuals with skills to deal with these changes and challenges. Many countries have realized the need to equip their young generation through education with multiple competencies. One of the students' competencies that become an international issue is literacy proficiency. Literacy is one of the main competencies that learners need to face the challenges of the 21st Century (Drew, 2012). The traditional definition of literacy is ability to read and write a short simple statement about individual's life (Krasny, 2013, p. 14). Today, literacy does not only evolve into being able to read, but also about being intellectual, and knowing how to research and solve complex problems. Therefore, literacy is fundamental for individuals to be able to participate in society and achieve their goals in work and life (Unesco, 2015, pp. 136–137). In addition, literacy also has an effect on all cognitive domains (Matute et al., 2012, p. 124).

Literacy proficiency has been assessed in Programme for International Students Assessment (PISA) that initiated by the Organization for Economic Co-operation and Development (OECD). The objectives of PISA are to assess the students' knowledge and skills in the real world and to prepare them with the long-life learning and the community participation (Stacey, 2011, p. 105). The result from PISA might be used by the government to, for example, monitor the educational system (Retnawati & Wulandari, 2019; Stacey, 2011). There are three aspects of literacy proficiency that are measured namely reading literacy, mathematical literacy, and scientific literacy proficiency (OECD PISA, 2013).

Mathematical literacy is related to the individual proficiency in formulating, identifying, understanding and implementing the mathematical foundations in multiple contexts that an individual needs in daily life (Ojose, 2011, p. 90). It is also needed to verify the solutions to problems that have been created (Hillman, 2014). Mathematical literacy important for students' competency to read, write, and speak about mathematics (Casey, 2013; Hillman, 2014). The result of many studies showed that mathematical literacy affected by some factors, e.g. school-level

characteristics (Chowa, Masa, 32 mos, & Ansong, 2015), and teachers' behaviors (Magen-Nagar, 2016, pp. 318–319) which are related to the implementation of learning in the classroom. Another factor arising from the students themselves, includes mathematics interest and self-concept (Uysal, 2015, p. 1670), grade level, gender (Magen-Nagar, 2016, p. 318), time allocated for learning mathematics (Savaş, Taş, & Duru, 2010, p. 113), learning facility at home (Türkan, Üner, & Alcı, 2015, p. 359), as well as the economic, social and cultural status (Stacey, 2011).

The mathematical literacy proficiency involves some aspect of mathematical thinking including reasoning, modelling, making connections between idea (NCCA, 2012, p. 8), mathematical concept, mathematical procedure, and mathematical fact. These aspects are central in explaining and predicting a phenomenon by emphasizing the competencies of process, content and context (OECD, 2031, p. 12). The domain of the content to assess include the Change and Relationship (CR), Shape and Space (SS), Quantity (QNT), and Uncertainty and Data (UD). The next domain is the context, that related to Personal (PER), Occupational (OCCP), Societal (SOC), and Scientific (SC). The process competencies in the mathematical literacy proficiency are to formulate (FRM), employ (EMP), and interpret (INT).

In order to measure the context competencies, a researcher should implement several types of test items. According to Shiel, Perkin, 9 Close, & Oldham (2007), the test item designs for the PISA assessment format are the traditional multiple-choice items, the complex multiple-choice items, the closed-constructed response items, the short-response items and the open-constructed response items." After the 1 students' responses, have been analyzed, the individual capacity classified into 7 levels, starting from below Level to Level 6. The descriptions of students' capacity at each level using 30 PISA classification.

Based on the results of a study conducted by PISA from 2000 to 2015, it was found that only few students were able to reach level 4 or above. Meanwhile, most of them still below level 2. Some parties claimed that the low level of students' literacy proficiency showed the failure of education system organized by the Indonesian government. Teachers are considered still not successful in training student literacy. But another consider that the results of the PISA study cannot be used as a basis to justify the quality of education in a country. The things that are debated are related to sampling, context, and differences in curriculum in each country.

Although the correlation between the results of the PISA and the quality of education is still debated, the results of PISA provide an overview of the growth of 11 mathematical literacy proficiency of students in Indonesia in recent years. However, PISA results have not been able to explain the mathematical literacy proficiency of students in various regions in Indonesia. This is due to the diversity of conditions in each region, such as school facilities and infrastructure, socio-cultural conditions of the community, and teacher competencies. In addition, students' mathematical abilities which also influence the literacy proficiency of students in each region are very diverse. One of the benchmarks can be seen from the results of the national examination (Balitbang Kemdikbud RI, 2014, 2015).

Problem of Research

Compare with all regions participating in the national examination in Indonesia, Yogyakarta was one of the regions that has achieved national exams above the national 17 range. However, the results of the national exam have not been able to provide an overview of the 17 students' mathematical literacy skills in the Yogyakarta. Further studies are needed to determine students' mathematical literacy skills in the Special Region of Yogyakarta.

Research Focus

The purpose of this study is to describe the growth of mathematical literacy proficiency of students in junior high school in Yogyakarta Special Region, Indonesia, based on the aspects of literacy content, process and context.

Research Methodology

Research Design

The study was an exploratory descriptive search with cross-sectional type research design. Within the study, the researcher would like to describe the growth of mathematical literacy proficiency of the students in 8th, 9th and 10th grade, especially trend in content, context, and process literacy. This study was conducted with the stages of preparing instrument by adapting items released PISA, proving the validity and estimating reliability, conduct tests to students, estimating the ability of students in the content, context, and process of mathematical literacy using the international items parameters, then presents the results of the analysis to describe the trend of development of students' mathematical literacy proficiency.

Population and Sample

The population of the study was junior high school students, the students ranging between 13 and 15 in the junior high schools and the students ranging between 15 and 16 years old in the senior high school within Yogyakarta Special Region in Indonesia. A combination of the stratified random sampling technique and the cluster random sampling technique was used to select the study participants. The sample comprised the 8th and 9th grade students from the junior high school degree and the 10th grade students from the senior high school degree in Yogyakarta Special Region. These students came from three different levels of schools, namely the high-performance, the moderate-performance and the low-performance category. This categorization was made based on the scores in the Mathematics National Examination. A total of 1,001 students participated in the study. 155 students were in their 8th grade (13-15 years old), 386 students were in their 9th grade (14-15 years old), and 460 students were in their 10th grade (15-16 years old).

Data Gathering

A test consisting of 30 items was used to collect the data in the study. The test items were adopted from the existing PISA test items, i.e. PISA 2003, 2007 and 2011. These items were translated into Bahasa Indonesia and the contexts were also adjusted to correspond Indonesian contexts. These test items were developed and validated by Wulandari (Jailani, Retnawati, Musfiqi, & Wulandari, 2015). The validity of the test instrument was examined through the content validity that was conducted in order to identify the relevance and the representativeness of the instrument toward the domain under assessment. It involved consulting the test instrument to experts (professional judgments) in relation to the domains of content and context and the domain of process in the PISA test-item model. The domain of test item content includes the four contents (QNT, CR, SS, and UD). The content validity was also examined to identify the coverage and the relevance of the test items to the domain of context (PER, SSC, OCCP, and SSC), and the domain of process (FRM, EMP, and INT). The experts also provided feedbacks regarding the material truth, the composition of substances in each domain, the test item readability and the relevance between the test item context and the students in Indonesia.

Cronbach's α was used as a measure of the reliability of the test that took the form of essay or multiple choices with the dichotomous data. The index of reliability was .707 and the SEM was

equal to 2.81. The Cronbach's α indicated the internal consistency at this level is considered reasonably high. Based on the SEM score, the researchers would like to imply that if the PISA test item model had been administered again then the score that the students would attain would be from $XT - 2.81$ until $XT + 2.81$.

Data Analysis

To analyze the growth of literacy proficiency, the students' ability was estimated first by implementing the Rasch model in the unidimensional item response theory. The estimation was conducted utilize the item parameters that had been equalized into the international study test item with the concordance model for the linking score. The concordance was conducted by implementing the Mean and Mean Method. The researcher subsequently interpreted the inter-year ability literacy proficiency, especially in content, context, and process literacy.

Table 1. Adjustment of Ability Parameter Into the PISA International Parameter

Domain	Sub-Domain	Mean of Difficulty Parameter		Beta	Equation of Ability Scale Conversion
		International Study	This Study		
Content	CR	0.935	-0.7005	1.6355	$\theta_i = \theta_n + 1.6355$
	QNT	0.2599	0.4768	-0.2169	$\theta_i = \theta_n - 0.2169$
	SS	-0.3173	-0.1807	-0.1367	$\theta_i = \theta_n - 0.1367$
	UD	-0.7122	-1.04188	0.3297	$\theta_i = \theta_n + 0.3297$
Context	OCCP	-0.6751	-1.7395	1.0644	$\theta_i = \theta_n + 1.0644$
	PER	0.5334	0.3713	0.16214	$\theta_i = \theta_n + 0.1621$
	SC	1.441	-0.5215	1.9625	$\theta_i = \theta_n + 1.9625$
	SOC	-1.3221	-0.3367	-0.9855	$\theta_i = \theta_n - 0.9855$
Process	EMP	-0.86963	-0.92664	0.0570	$\theta_i = \theta_n + 0.0570$
	FRM	0.036693	-0.298	0.3347	$\theta_i = \theta_n + 0.3347$
	INT	0.9454	0.4944	0.451	$\theta_i = \theta_n + 0.451$

The steps of data analysis were as follows: (1) Estimating the item parameters and the ability parameters by operating the Rasch model proposed by Masters (2010). It was applied to both the students' response from the multiple-choice test items and the dichotomous and polytomous constructed response test item. CONQUEST program was used in the analysis (Wu, Adams, & Wilson, 1997) with the calibration concurrent model for the 8th, 9th and 10th grade; (2) Adjusting the test item parameters to the international test item parameters by means of Mean and Mean method (Hambleton & Swaminathan, 1985). It was conducted until the researcher attained the adjustment of the item parameter to the international scale for the 8th, 9th and 10th grade. The results of the adjustment is presented in Table 1; (3) Implementing the modification equation from the second step in order to adjust the capacity parameter for each class; (4) performing a descriptive analysis in order to present the growth of the mathematical literacy proficiency of the students for the 8th, 9th and 10th grade; and (5) categorizing the participants' ability in accordance with the data analysis within the PISA model for each classroom by using the results of participants' capacity estimation.

The participants' ability in accordance with the data analysis within the PISA model, the student ability scale should be transformed to a mean that was equal to 500 and the standard deviation that was equal to 100. The results of the transformation were then categorized into 7 levels that consisted of Below Level 1, Level 1, Level 2, Level 3, Level 4, Level 5 and Level 6 in accordance to the Technical Report (OECD, 2016). Based on the results of transformation and the categorization of literacy proficiency, the researcher subsequently monitored the development trend.

The growth of the mathematical literacy proficiency described by referring to the standard and by considering the aspect of literacy content, context and process.

Research Results

Literacy Based on the Content

Fig. 1 shows that the mathematical literacy proficiency of the 10th grade students was better than that of the 8th and 9th grade students, particularly for the content of QNT, SS, and UD. This finding shows that there was an improvement on the 8th, 9th and 10th grade students' mathematical literacy for the content of QNT, SS, and UD. On the contrary, the 8th grade students had the highest mathematical literacy proficiency in comparison to the 9th and 10th grade students for the content of CR. This finding shows that there was a decreasing on the students' mathematical literacy proficiency for the content of CR.

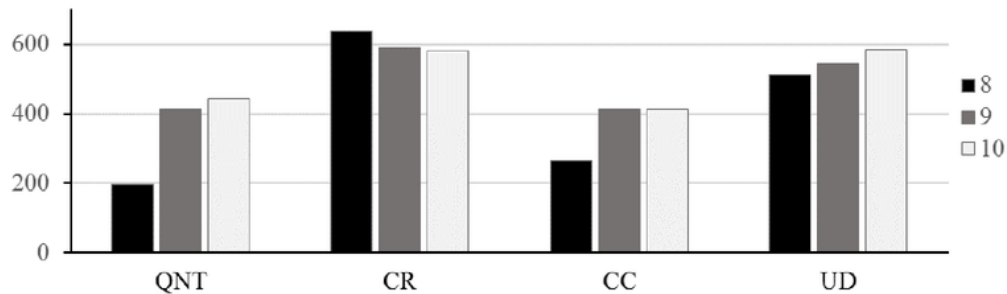


Fig. 1. The Mathematical Literacy Proficiency Based on Content

The growth of the students' mathematical literacy in the low school level improved among the 8th, 9th and 10th grade for the content of QNT, SS, UD (Fig. 2). However, the highest score in CR was obtained by the 8th grade students. The growth of students' mathematical literacy proficiency in the moderate school tended to be unstable which implied the increasing and the decreasing proficiency in accordance with the students' grade. For example, as having been displayed in the Fig. 2, the literacy proficiency for the content of QNT is increasing from the 8th grade to the 9th grade but is decreasing from the 9th grade to the 10th grade. Similar result is obtained for the content of algebra. In the meantime, the students' mathematical literacy proficiency in the high school level had improved along with the students' grade for all of the PISA contents that had been administered.

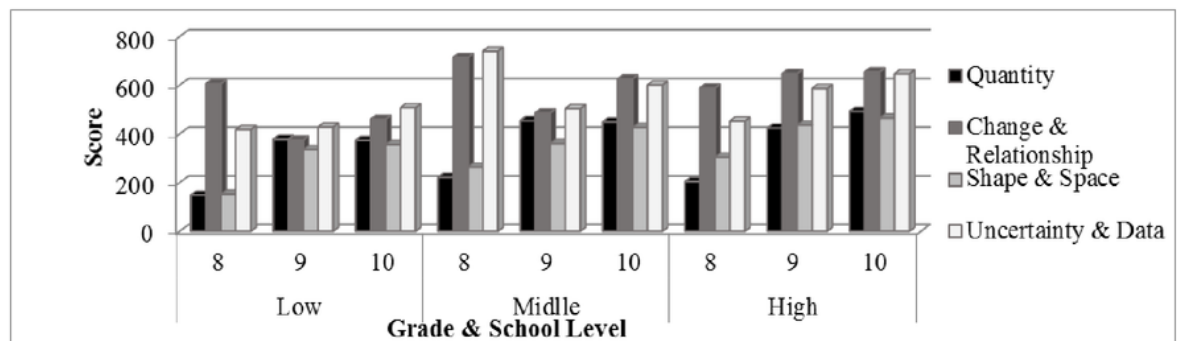


Fig. 2. The Mathematical Literacy Proficiency Based on Content and School Level

Overall, there was an improvement on the students' mathematical literacy in the 9th and 10th grade in accordance with the school level. The higher the school level was, the higher the mathematical literacy proficiency that the students attained. However, for the 8th grade students, the moderate school level attained the highest score in comparison to the high school level. The possible reason was that the 8th grade was the most prominent.

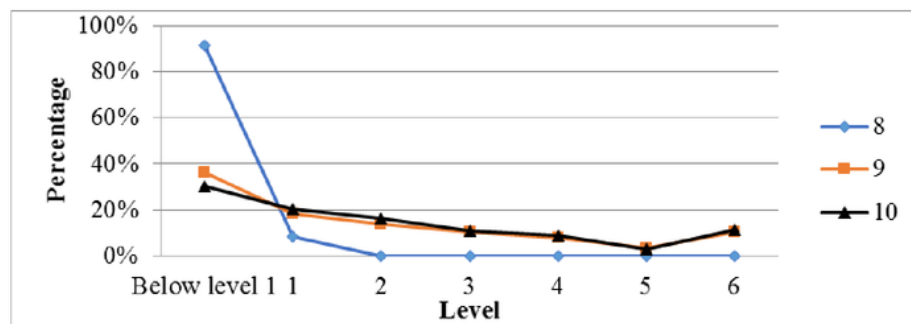


Fig. 3. The Mathematical Literacy on the Content of QNT

Fig. 3 shows that there was an improvement of the students' mathematical literacy and that the students achieved Level 1 to Level 6 for the content of QNT. There were 10% of the 9th and 10th grade students who had been able to achieve the Level 6. However, in general the students' mathematical literacy for the content of QNT was low because most of the students only achieved the following category: Below Level 1 – Level 3. Furthermore, there were only 20% students who achieved Level 4 – Level 6.

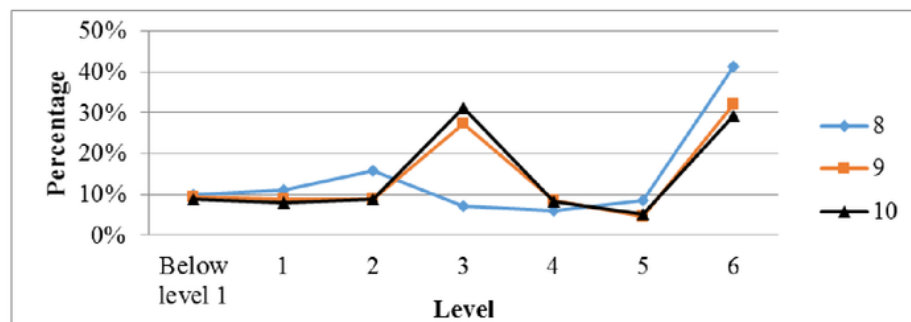


Fig. 4. The Level of Mathematical Literacy Proficiency on the Content of CR

According to the students' grade, the mathematical literacy proficiency for the content of a CR tended to be unstable (Fig. 4). However, there were many 8th grade students who were in the "Level 6" category compared to the 9th and 10th grade students. This result might be due to the fact that the learning material of algebra is taught to students in their 8th grade.

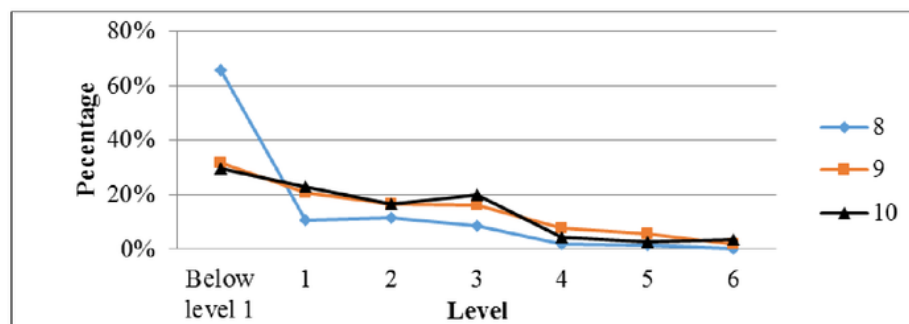


Fig. 5. The Level of Mathematical Literacy proficiency on the Content of SS

Another content that became the focus of assessment in the mathematical literacy proficiency was the content of SS. Fig. 5 showed that, overall, the mathematical literacy proficiency of students in their 8th grade, 9th grade, and 10th improved along with the grade level. However, in general, the students' mathematical literacy proficiency for the content of SS still low because most of the students achieved the below level 1–level 3 category. Fig. 6 showed that the growth of mathematical literacy proficiency for the content of UD from the 8th grade students until the 10th grade students improved.

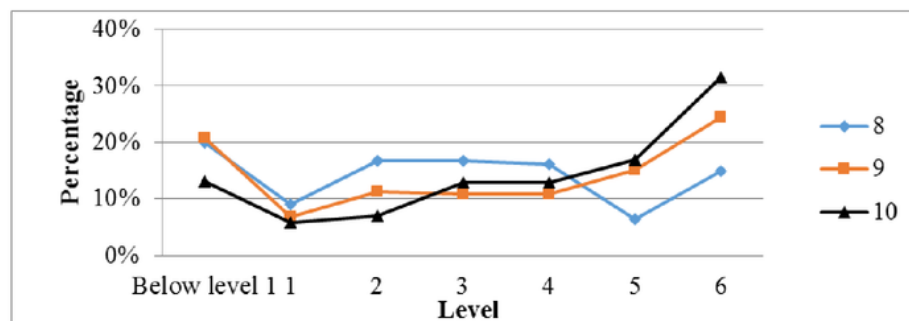


Fig. 6. The Mathematical Literacy Proficiency on the Content of UD

Literacy Proficiency Based on the Context

The contexts that had been implemented in the mathematical literacy proficiency were in accordance with the standards that had been implemented in the PISA and the contexts included the use of Mathematics in the personal life (PER), social life (SOC), occupation (OCC), and science (SC). Being adjusted to the level of ability that became the standards of PISA, the students' mathematical literacy proficiency was also differentiated for each domain.

Based on the Fig. 7, the researchers found that the students' mathematical literacy proficiency improved in all contexts. The improvement was in accordance with the students' grade level. The findings showed that the students' mathematical literacy proficiency in the Province of Yogyakarta Special Region improved in accordance to the grade level.

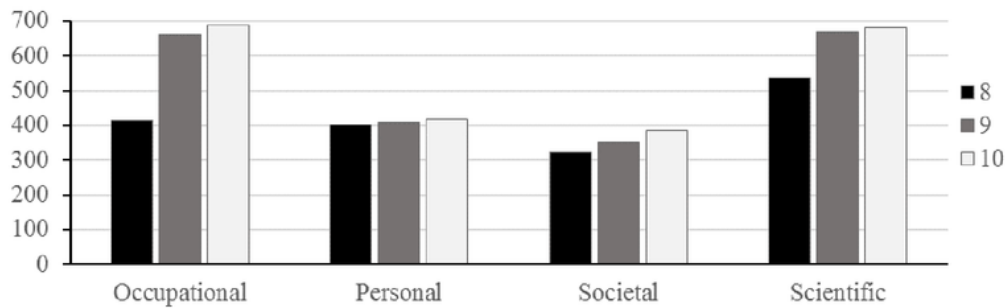


Fig. 7. The Mathematical Literacy Proficiency Based on the Context

However, in this case the 8th and the 9th grade students achieved the highest score for the SC context while the 10th grade students achieved the highest score for the OCC context. Meanwhile, for the PER and SOC context, the students achieved lower score than the other two contexts (OCC, and SC). The reason was that the PER and SOC context test items were designed under the process of interpreting, implementing and evaluating the mathematical results (the third domain of process) and under the indicator of drawing the conclusion on the mathematical results toward the contextual problems and of evaluating and providing logical reasons or arguments toward the mathematical results that had been attained. In addition, the students' ability in this domain of process was lower than their ability in the other two domains of process (FRM, and EMP).

Fig. 8 shows that the students' mathematical literacy proficiency in the low, moderate, and the high school level increased from the 8th grade to the 9th grade and from the 9th to the 10th grade for the OCC and SC context. On the contrary, the students' mathematical literacy proficiency for the PER and SOC context in the low and moderate school level decreased from the 8th to the 9th grade but increased from the 9th to the 10th grade. Then, for all contexts the students' mathematical literacy proficiency increased from the 8th grade to the 9th grade and from the 9th grade to the 10th grade. In general, the 9th and the 10th grade students' mathematical literacy proficiency increased for all contexts in the low, moderate and high-level schools. The reason was that the model level school that had been sampled was the best moderate level school.

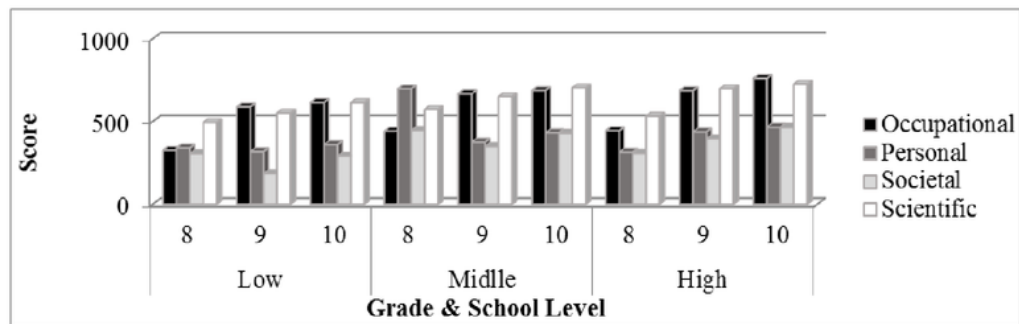


Fig. 8. Mathematical Literacy Proficiency Based on the Context and the School Level

Subsequently, the researchers display the growth of the students' mathematical literacy proficiency based on each context (Fig. 9). The growth of grade 8 to 10 students' mathematical literacy proficiency for the OCC context. The OCC context was related to the students' life in the

school or in the working environment. For the OCC context in the 8th grade, the percentage showed that the 8th grade students' ability in the Province of Yogyakarta Special Region was equally distributed from the "Below Level 1" category until the "Level 5" category for the OCC context; most of the students were in "Below Level 1" category and there were very few students or there were almost none of the students who were in "Level 6" category.

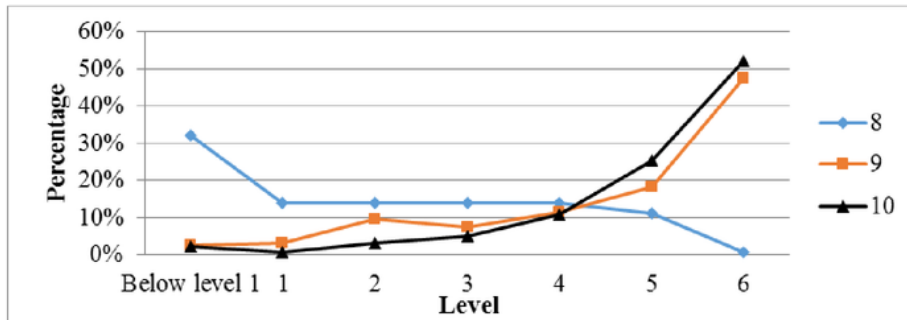


Fig. 9. The Level of Mathematical Literacy Proficiency on the OCC Context

The result showed in Fig. 9 suggests that the improvement between the 9th grade and the 10th grade students' mathematical literacy proficiency was almost similar. The number of the 9th grade and the 10th grade students who were in "Below Level 1" category were very few or near 0% and there were less than 5% of the students who were in "Level 1" category. The number of the 10th grade students who were in "Level 5" and the "Level 6" category was higher than that of the 9th grade students. The Fig. showed that based on the OCC context the students' mathematical literacy proficiency improved from the 8th grade to the 9th grade and from the 9th grade to the 10th grade in accordance with the students' grade level.

The domain of PER context had direct relationship to the students' daily activities. In the daily activities, the students definitely encountered the personal problems that demanded immediate solutions. The growth of the students' mathematical literacy proficiency from the 8th grade to the 10th grade students is displayed in Fig. 10.

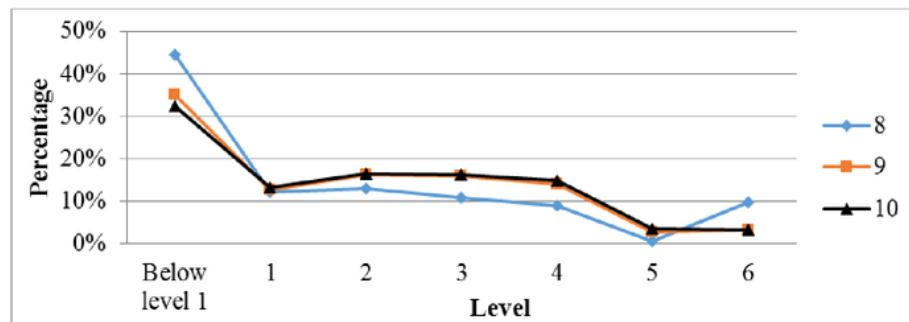


Fig. 10. The Level of Mathematical Literacy proficiency on the PER Context

Fig. 10 shows that for the PER context 30% of the 8th, the 9th and the 10th grade students were in "Below Level 1" category and 10% of the 8th, the 9th and the 10th grade students were in "Level 1" category. In addition, still based on the above Fig. it was apparent that the students' mathematical

literacy proficiency improved from the 8th grade to the 9th grade and from the 9th grade to the 10th grade. The improvement was found in the decreasing number of the 9th and the 10th grade students who were in “Below Level 1” category and the increasing number of the students who were in “Level 2,” “Level 3,” “Level 4” and “Level 5” category. However, in overall the students’ mathematical literacy proficiency for the PER context was still low because more than 70% of the students were still in “Below Level 1,” “Level 1,” “Level 2” and “Level 3” categories and around 20% of the students were in “Level 4,” “Level 5” and “Level 6” categories.

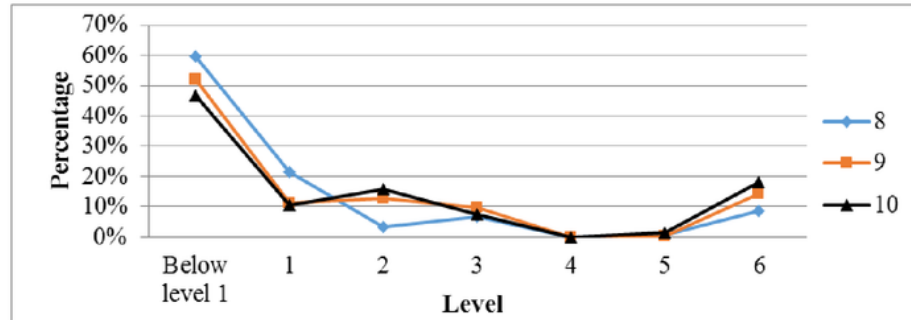


Fig. 11. The Level of Mathematical Literacy proficiency on the SOC Context

The SOC context was related to the use of mathematical knowledge in the SOC life and the wider neighborhood in the daily life. Fig. 11 show that the growth of the students’ mathematical literacy proficiency based on the SOC context. Fig. 11 suggests that for the SOC context, most of the students in grade 8 to 10 were in “Below Level 1” category. The percentage above showed that based on the SOC context the students’ mathematical literacy proficiency improved from the 8th grade to the 9th grade and from the 9th grade to the 10th grade. The improvement was found in the decreasing number of 9th grade and 10th grade students who were in “Below Level 1” and “Level 1” category and the increasing number of the students who were in “Level 2” category and above. However, in general the students’ mathematical literacy proficiency for the SOC context was still low since most of the students were in “Below Level 1,” “Level 1,” “Level 2” and “Level 3” categories.

The SC context was related to the scientific activities that more abstract and that demanded theoretical mastery and understanding in performing the mathematical problem solution (see Fig. 12). For the SC context, Fig. 12 shows that the students’ mathematical literacy proficiency improved from the 8th grade to the 9th grade and from the 9th grade to the 10th grade in accordance with the students’ grade level. In addition, for the SC context more than 50% of the students in the Province of Yogyakarta Special Region achieved the “Level 4,” the “Level 5” and the “Level 6” category.

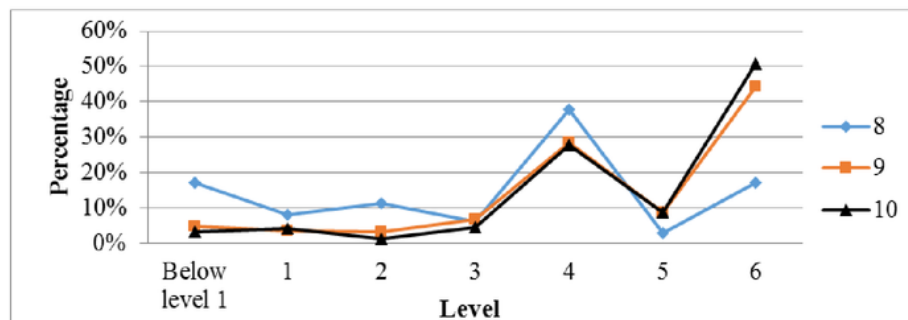


Fig. 12. The Level of Mathematical Literacy Proficiency on the SC Context

Literacy Proficiency Based on the Process

The students' literacy proficiency is best viewed in the domain of mathematical process that described the students' ability in associating the context of problem solving in mathematics. With respect to the three domains of process that became the standard of PISA, they are FRM, EMP, and INT (OECD, 2006). The students' literacy proficiency was also classified into each domain of process. The mapping of the 8th, 9th and 10th grade students' mathematical literacy proficiency in the domain of process is presented in Fig. 13.

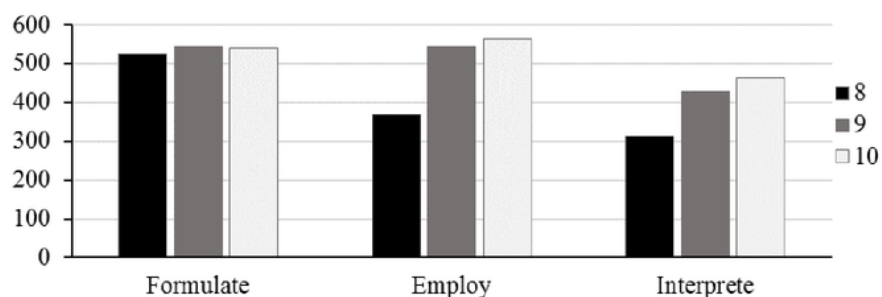


Fig. 13. Mathematical Literacy Proficiency Based on the Process

Fig. 13 shows that for the domain of process in formulating the mathematical situations (formulate) the mathematical literacy proficiency of 8th, 9th and 10th grade of the students improved along with their grade level. Similar finding was also found in the domain of employing the mathematical concepts, facts, procedures and reasoning (EMP), and interpreting, implementing and evaluating the mathematical results (INT). However, the students' mathematical literacy proficiency in the process of employing the mathematical concepts, facts, procedures and reasoning was lower than that in the process of formulating the mathematical situations. Similarly, the students' mathematical literacy proficiency in the process of interpreting, implementing and evaluating the mathematical results was the lowest compared to the other two domains of process. These findings implied that the students were likely able to employ the mathematical concepts, facts, procedures and reasoning appropriately if they could formulate the mathematical situations. However, there were also some students who might formulate the mathematical situations but they were not able to solve the mathematical situations by employing the mathematical concepts, facts, procedures and reasoning. The students might also interpret, implement and evaluate the mathematical situations appropriately if they were able to formulate the mathematical situations and to employ the mathematical concepts, facts, procedures and reasoning appropriately.

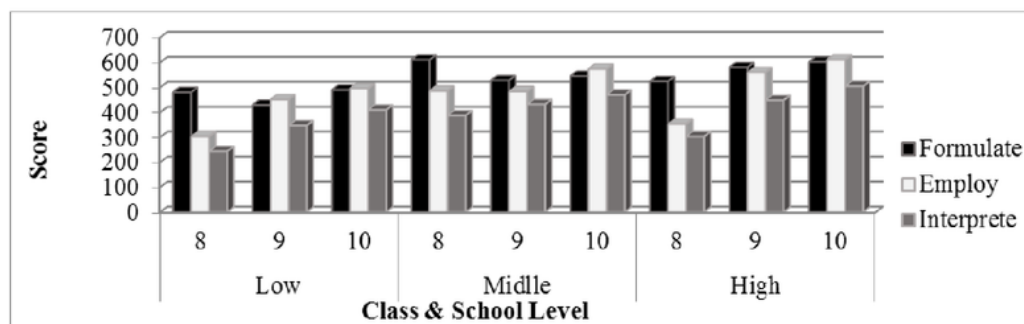


Fig. 14. **The Mathematical Literacy Proficiency Based on Process and School Level**

In addition to the domain of process, the growth of the students' mathematical literacy observed by the school level (i.e., low, moderate and high). The growth of the students' mathematical literacy proficiency for the domain of process in each school level is presented in Fig. 14. The result in Fig. 14 showed that the growth of the 8th grade students had improved from the low-level school to the moderate-level school. However, the growth of the literacy proficiency had decreased in the high-level school in terms of the domain of process. In overall, mathematical literacy proficiency of the students had improved in accordance with the increasing school level and quality.

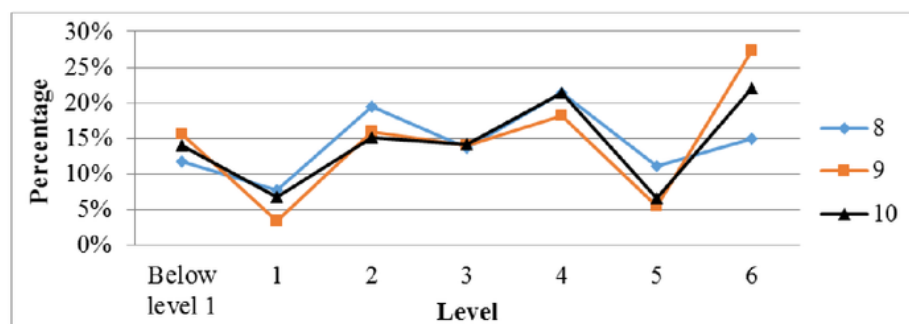


Fig. 15. **The Mathematical Literacy Proficiency to Formulate**

Then, the growth of the students' mathematical literacy proficiency was examined under each domain of process. The first domain was to formulate the mathematical situations (Fig. 15). The second domain was to employ the mathematical concepts, facts, procedures and reasoning. The growth of the students' mathematical literacy proficiency from the 8th grade until the 9th grade in the second domain is showed in Fig. 16.

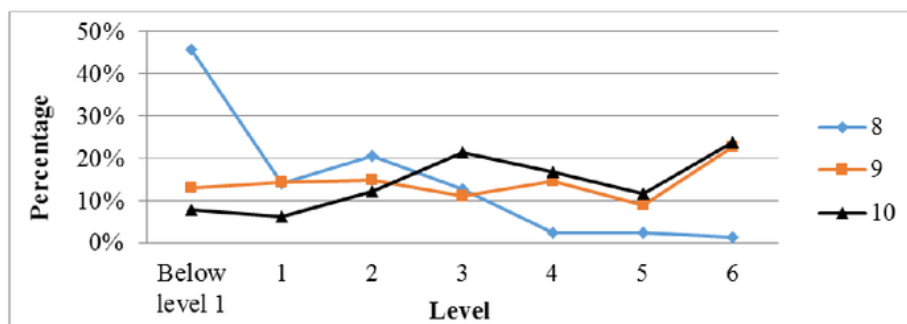


Fig. 16. The Mathematical Literacy Proficiency to Employ

These findings showed that there had been improvement of the students' mathematical literacy proficiency in accordance with their grade level. The improvement can be seen in the decreasing percentage of the 9th grade and the 10th grade students who were in "Below Level 1" category and the increasing percentage of the students who were in "Level 6" category.

Subsequently, the researchers examined the students' mathematical literacy proficiency based on the third domain of process, namely to formulate, to employ, and to interpret the mathematical results. In the Fig. 17 presents the mathematical literacy proficiency of the students' in the Province of Yogyakarta Special Region on the third domain of process.

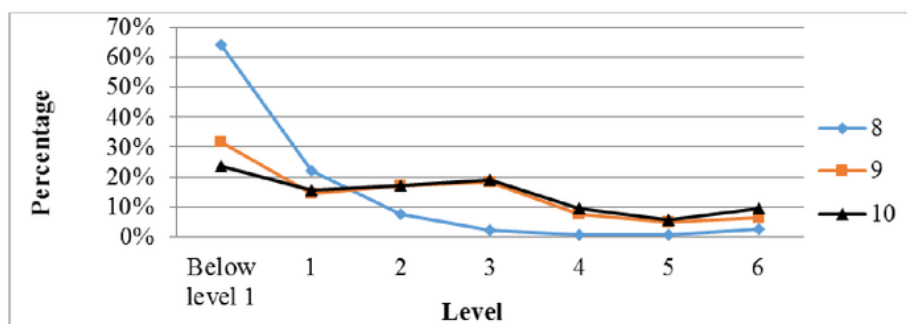


Fig. 17. The Mathematical Literacy Proficiency to Formulate, Employ, and Interpret

The percentage showed that there was improvement on the students' mathematical literacy proficiency from the 8th grade to the 9th grade and in the 9th grade to the 10th grade although there were few students in "Level 5" and "Level 6". There was a decrease in the number of grade 9 students and 10th grade students who were in "Below Level 1" category and there had been increasing number of students who were in "Level 4," "Level 5" and "Level 6" category.

Discussion

The results of this study showed that there was an improvement of mathematical literacy proficiency of students from the 8th grade to the 9th grade and to the 10th grade. The higher the grade was, the higher the students' achievement in the score of mathematical literacy proficiency. These results indicate that the achievement level of the students' mathematical literacy proficiency was also influenced by the grade. However, the influence of age or year level was not significant. This result is in accordance with the work of Magen-Nagar (2016, p. 318); Jabor, Machtmes,

Kungu, Buntat, & Nordin (2011), and also Thoren, Heinig, & Brunner (2016) who found that age and school level influenced the students' literacy proficiency. The reason is that the mathematics learning material learned by students in grades 9 and 10 as stated in the standards of the Indonesian curriculum is more comprehensive than students in grades 8 did. As a result, the higher the students' grade was the more learning materials that supported the improvement of mathematical literacy would be.

In relation to the content of mathematical literacy there was a tendency that the literacy within the content of CR and UD had been higher in comparison to the content of QNT and the content of SS. Although students' literacy in numbers, geometry, increased from grade 8 to 10, the students' ability was still in the low category. It can be seen from the small number of students in level 4 to 6. In numbers, most of the students in grade 8 to 10 could not achieve level 4. All students in year 8 could not even achieve level 2. This result shows that students in grade 8 found difficulties in formulating information in most of the test items. They could only answer questions related to geometry and numbers that have been clearly defined. The students' low ability in the geometrical content indicated their low ability in spatial skills. This is in line with previous studies, e.g. Hannafin, Truxaw, Vermillion, & Liu (2008), and Novak & Tassell (2017) that spatial abilities are directly related to mathematics ability, particularly in geometry.

The student's literacy in algebra was not significantly different among students in their year 8 to 10. This is supported by the finding from previous research by Eze, Ezenwafor, & Obi (2015, p. 99); Josiah & Adejoke (2014, p. 475) that students age is not a significant correlate of students' algebra skills. However, student's literacy in algebra is better than their literacy in numbers, geometry and uncertainty dan statistics. Most of the students' scores were above 669 (level 6). The possible reason is that algebra has been taught to students 12 year 8 than those in year 9 and 10.

Concerning achievement related to the process of formulating mathematical situations, of employing the mathematical concepts, facts, procedures and reasoning and of interpreting, implementing and evaluating the mathematical results, there was an improvement in the students' mathematical literacy from the 8th to the 9th grade and from the 9th to the 10th grade in accordance with the students' grade level. Meanwhile, in overall the students' ability in the process of employing the mathematical concepts, facts, procedures and reasoning was lower than their ability in the process of formulating the mathematical solutions. Similarly, the students' score of mathematical literacy in the process of interpreting, employing and evaluating the mathematical results was the lowest one in comparison to their scores in the other 5 domains of process. These findings showed that the students were likely able to employ the mathematical concepts, facts, procedures and reasoning appropriately if they could formulate the mathematical problems. The students' low ability in the domain of interpreting shows that they were not able to infer, apply, and evaluate problem solutions. Similarly, Tambychik & Meerah (2010, p. 150) also found that students found difficulties during making meaningful connection in the problem. Furthermore, Jupri, Drijvers, & Heuvel-Panhuizen (2014, p. 51) also found that students experienced difficulties in solving problems due to their inability in applying the reverse strategy (Jupri et al., 2014, p. 51) as a step in verifying solutions to the problems before they come to a conclusion.

For the achievement related to the context, the students' score of mathematical literacy in PER and SOC context was lower than their scores in the OCC and the SC context. The reason was that within the learning process, the mathematics learning materials directed the students to understand and to master the knowledge as a preparation to pursue higher level education or to find a job. As a result, PER and SOC context had rarely been implemented in the mathematics learning materials. This made the students' find difficulties in answering questions that used the contexts. This is in line with the studies by Abdullah, Abidin, & Ali (2015, p. 140), and Aoyama (2007, p. 308) when they had to answer questions related to contexts that they have not learned before. This result suggests the need to integrate various contexts in the learning and teaching process.

The students' achievement score in mathematical literacy was influenced by the school level. There was correlation between the scores in mathematical literacy and achievement in national examination. The higher the school performance in national exams, the higher the achievements of its students of the school in mathematical literacy ability. The good input of the students, learning process and learning achievement were usually had by school that had high achievement. These findings had been in accordance with the finding from Bohlmann & Pretorius (2008), and also Chowa et al. (2015) that school-level characteristics affect academic achievement. There were many factors influenced the students' mathematical literacy ability, the score in the content of CR and of UD was higher than that in the content of QNT and of SS both based on the school grade and the school level. The possible factor was the material contents in every grade. The content of CR and of uncertainty dominated the contents in the 8th grade and the 9th grade in Indonesian Curriculum.

Conclusions and Implications

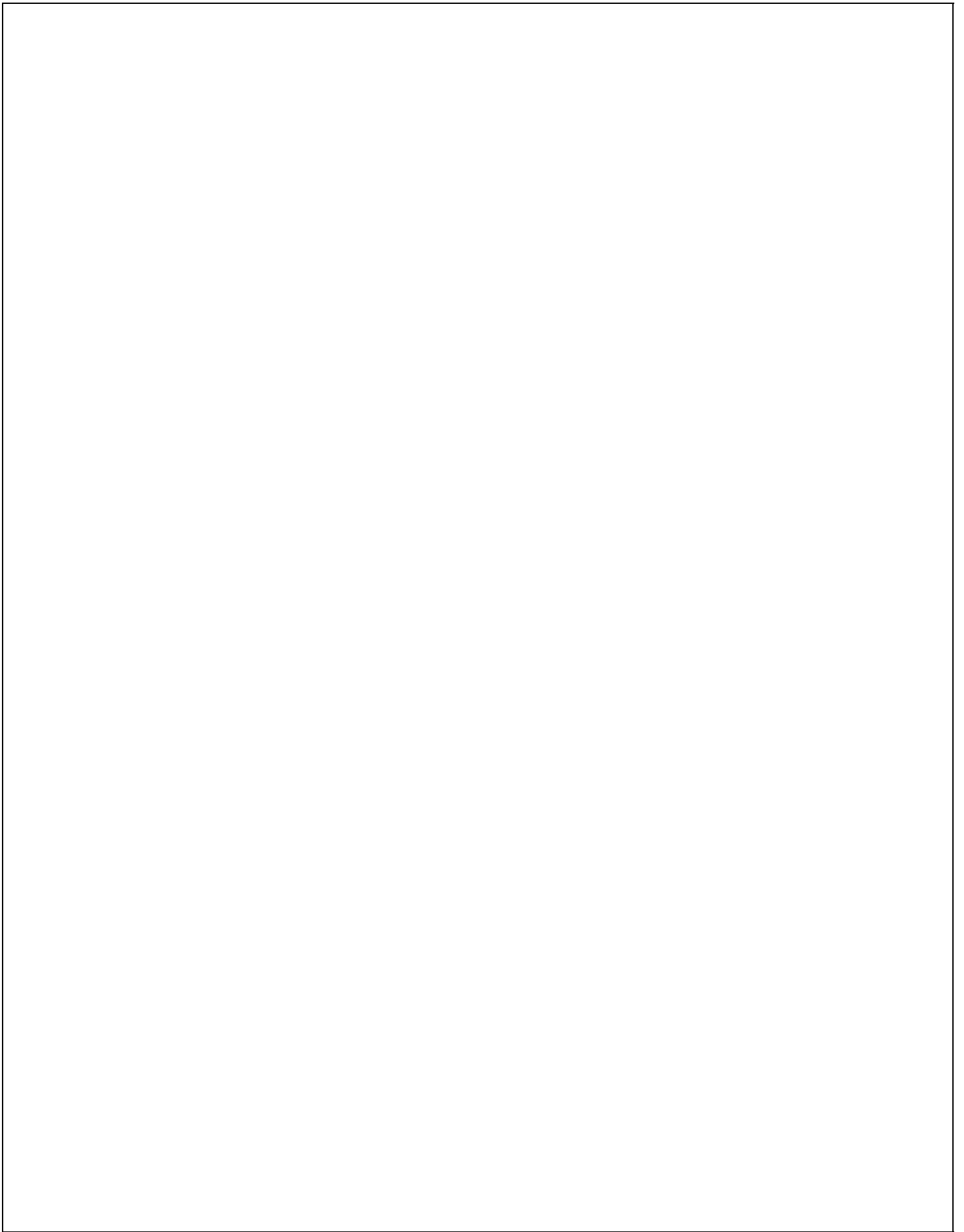
The research result showed that the students' mathematical literacy was unsatisfying. It should be get attention from government, teacher, and researcher. The mathematics teaching quality, including process of planning, implementing and assessing learning outcomes should support the students' mathematical literacy proficiency. Although the quality of schools affects students' ability (Chowa et al., 2015), but the quality of teaching is most important key to improve the students' achievement in mathematical literacy (Retnawati, Djidu, Kartianom, Apino, & Anazifa, 2018). The improvement toward the learning quality and the learning assessment can be pursued through the integration of the literacy into the mathematics learning process (Hillman, 2014, p. 403), and also to the other subjects. Besides that, mathematics education programs should be developed to help students be able to make real life connections (Djidu & Retnawati, 2018; Yavuz, İlgün Dibek, & Yalçın, 2017). Therefore, further studies are necessary to determine the strategies that can be used to train the students' mathematical literacy, and also the development of teaching sets to teach mathematical literacy.

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