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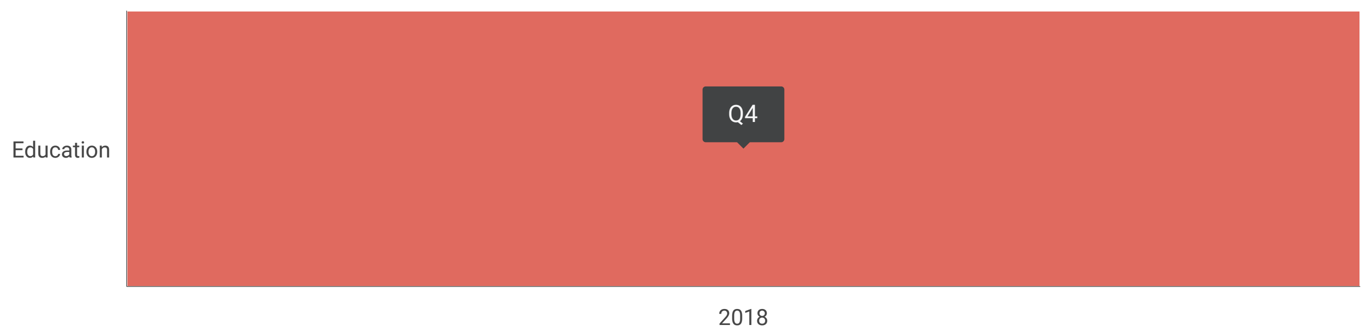

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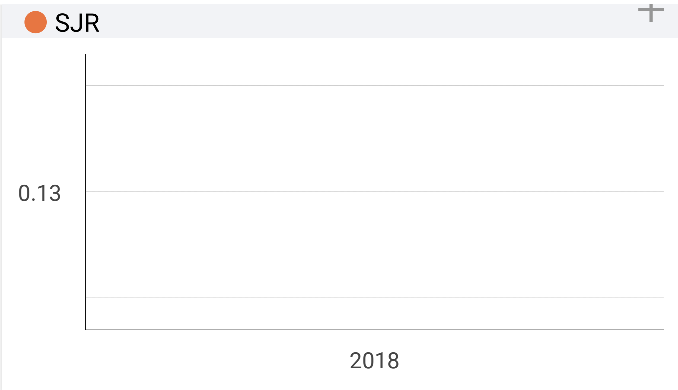

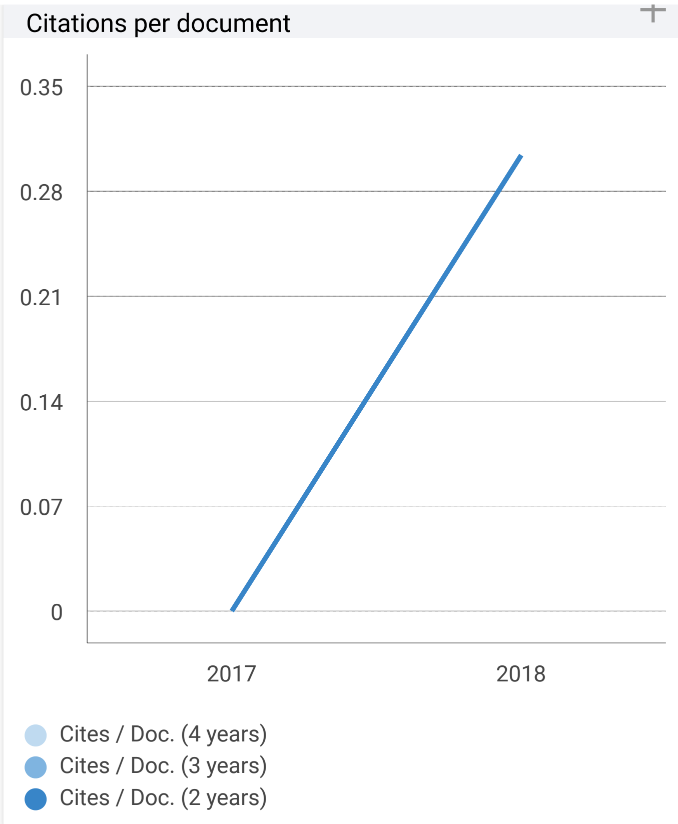

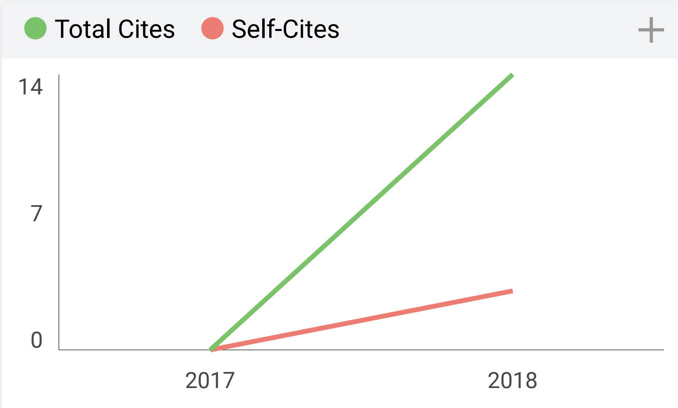

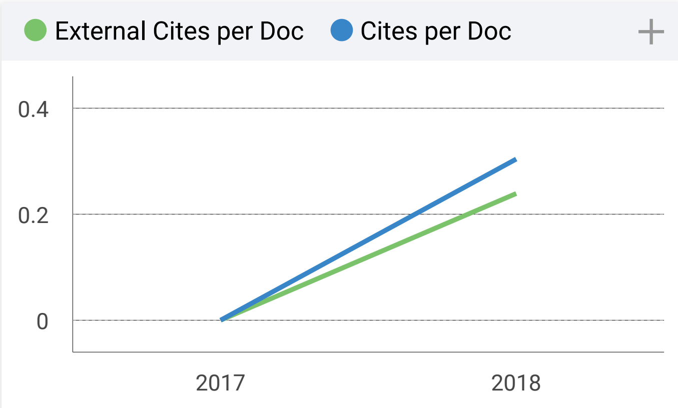

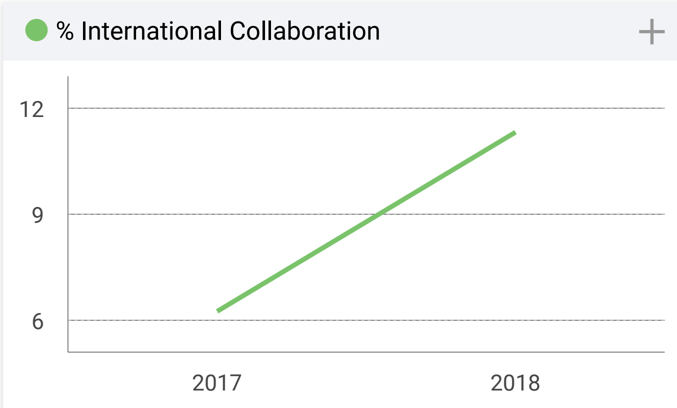

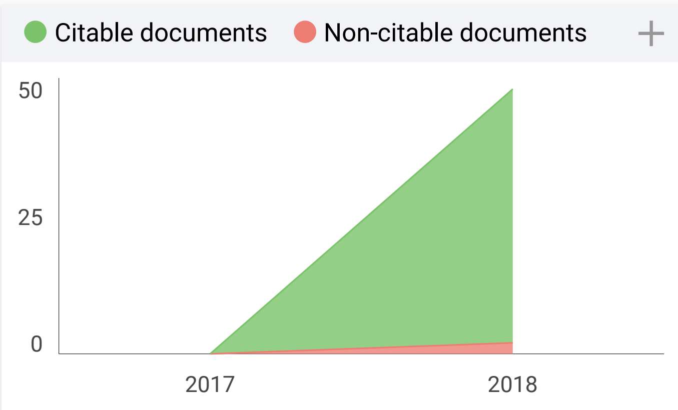

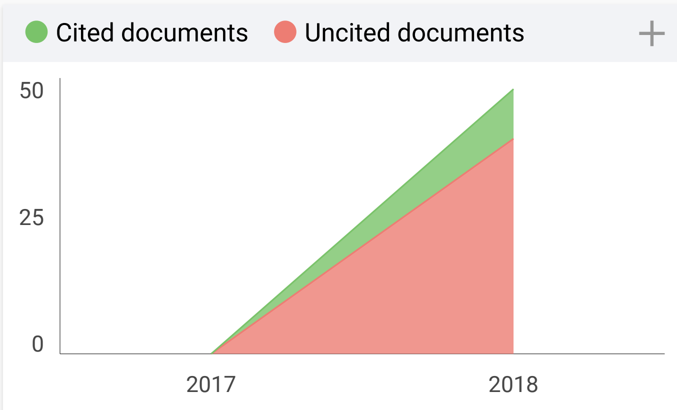

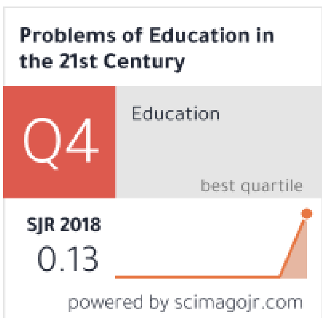

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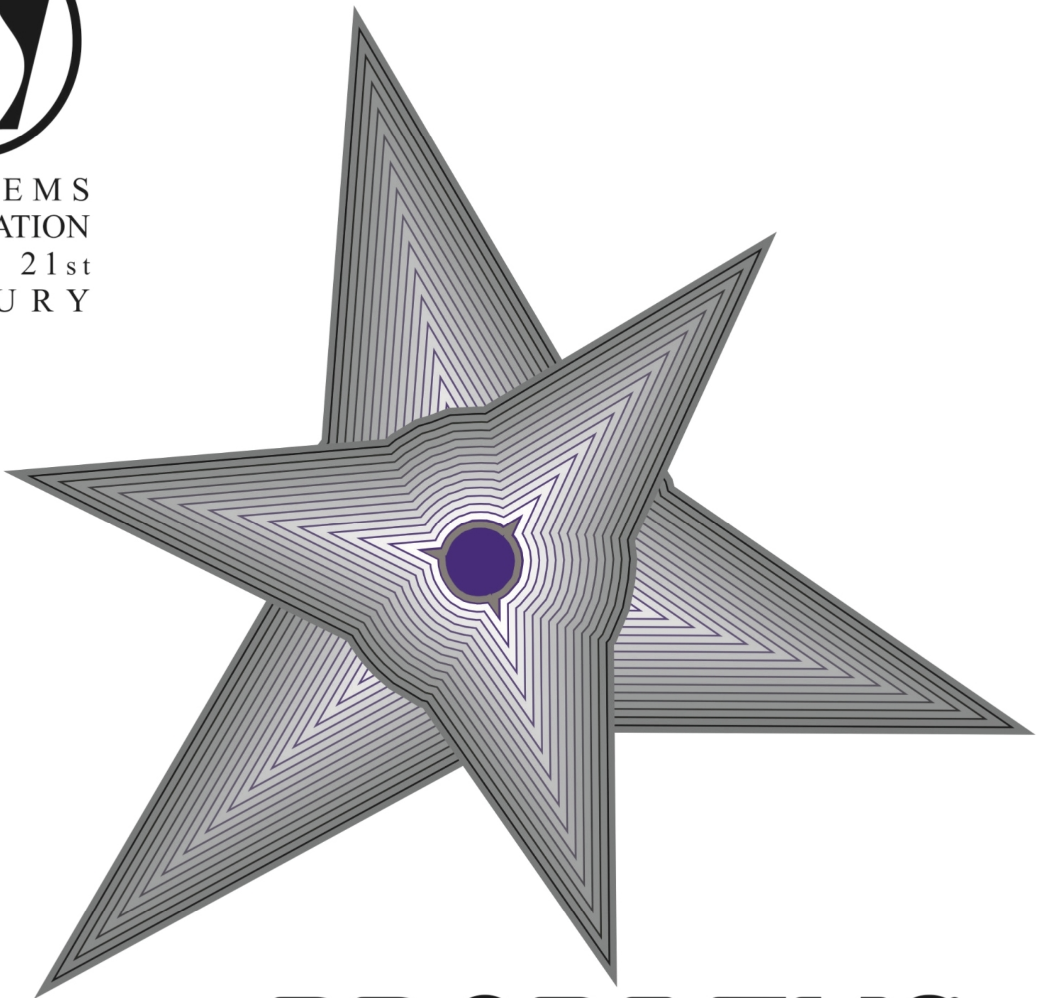

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MATHEMATICAL LITERACY PROFICIENCY DEVELOPMENT BASED ON CONTENT, CONTEXT, AND PROCESS

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Abstract

The literacy proficiency development is one of concerns in education generally, so is in mathematics education as well. The growth of literacy proficiency is one of the issues in education, because it is very important to problem solving skills in students' real life. This research aimed to describe the growth of lower secondary school and upper secondary school students' mathematical literacy proficiency in Yogyakarta Special Region province, Indonesia. Three mathematical literacy proficiency aspects were examined in the research, namely content, process and context. It was an exploratory descriptive research with cross-sectional type research design. The population was 1,001 lower secondary school and upper-secondary school students ranging between 13 and 16 years old. They were selected using the combination of stratified and the cluster random sampling technique. A test consisting of 30 items, was adopted from the existing PISA test items used to collect the data in the research. 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 based on content, context, and process was still low. In the content and context domain, there was progress from 8th grade to 9th, from 9th grade to 10th grade. In the process domain, the development of students' abilities on formulate showed relatively the same results for 8th, 9th, and 10th were around 500, and in the employ and interpret process domain, there was a development of abilities from 8th to 9th, and from 9th to 10th grade.
Keywords: *mathematics literacy proficiency development, domains based on PISA study.*

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' competences that has 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 the 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

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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 was 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 as reading literacy, mathematical literacy, and scientific literacy proficiency (OECD, 2017).

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 is important for students' competency to read, write, and speak about mathematics (Atsnan, Gazali, & Nareki, 2018; Casey, 2013; Hillman, 2014). The result of many studies showed that mathematical literacy is affected by some factors, e.g. school-level characteristics (Chowa, Masa, Ramos, & Ansong, 2015; Kartianom & Ndayizeye, 2017), 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 (Kartianom & Ndayizeye, 2017Stacey, 2011).

The mathematical literacy proficiency involves some aspects 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, 2006). The domain of the content to assess includes the Change and Relationship (CR), Shape and Space (SS), Quantity (QNT), and Uncertainty and Data (UD). The next domain is the context that is 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, Perkins, Close, and 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 students' responses have been analyzed, the individual capacity was classified into 7 levels, starting from below Level 1 to Level 6. The descriptions of students' capacity are at each level using the PISA classification.

Research Problem

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 are still below level 2. Some parties claimed that the low level of students' literacy proficiency showed the failure of education system organized by the government. Teachers are considered still not successful in training student literacy. But the other 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.

Retnawati and Wulandari (2019) described literacy proficiency development, but their research had not explained the development of literacy proficiency based on its domain, namely content, context, and process.

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 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 based on its domain. In addition, students' mathematical abilities which also influence the literacy proficiency of students were very diverse (Balitbang Kemdikbud RI, 2014, 2015).

By utilizing the development of literacy proficiency in detail, educators can find out in which part of the students' development that needs to be improved. Likewise, further research can be carried out, in order to ensure optimal proficiency development, for example, support for teaching materials and increasing the ability of teachers to practice literacy. Based on this problem, a research to describe the growth of mathematical literacy based on its domain was needed.

Research Focus

The focus of this research was the growth of mathematical literacy proficiency. Based on the PISA international study, the literacy proficiency could be determined in three domains, that were content, process and context (OECD, 2006).

Research Aims

The aims of this research were to describe the growth of mathematical literacy proficiency of students based on the domains of literacy, that are content, process and context domain.

Research Questions

The research questions were:

1. How was the growth of literacy mathematics based on content domain?
2. How was the growth of literacy mathematics based on context domain?
3. How was the growth of literacy mathematics based on process domain?

Research Methodology

Research Design

The research was an exploratory descriptive research with cross-sectional type research design. Within the research, the researcher would like to describe the growth of mathematical literacy proficiency of the students in the 8th, 9th and 10th grade, especially the trend in content, context, and process literacy. This research 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 item parameters, then present the results of the analysis to describe the trend of development of students' mathematical literacy proficiency in content, context, and process domain. The data collecting was conducted in 2015, and data analysis was conducted in 2016-2017.

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Population and Sample

The population of the research was about 125,000 lower secondary school and secondary school students, the students ranging between 13 and 15 in the lower secondary schools and the students ranging between 15 and 16 years old in the upper secondary schools in Yogyakarta Special Region Province in Indonesia. A combination of the stratified random sampling technique and the cluster random sampling technique was used to select the research participants. The sample comprised the 8th and 9th *grade* students from the lower secondary school and upper secondary school degree and the 10th grade students from the upper secondary 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 research, 464 male and 537 female, 155 students were in their 8th grade (13-14 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). The sample size determined by formula to estimate 95% confidence interval for mean of students' literacy proficiency, using error 6.5 and standard deviation 100, and got minimum sample size 909.25.

When data collecting was conducted, researchers informed the teachers and students that the test was conducted only for research. All of identities about students, teachers, and school were coded. The results of the test were not used for any decision about students.

Instrument

A test consisting of 30 items was used to collect the data in the research. 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 (Indonesian language) 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 to 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 choice 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

The students' abilities were estimated first by implementing the Rasch model in the unidimensional item response theory. The abilities were used to analyze the growth of literacy proficiency. The estimation was conducted to 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 Research	This Research		
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 are 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.

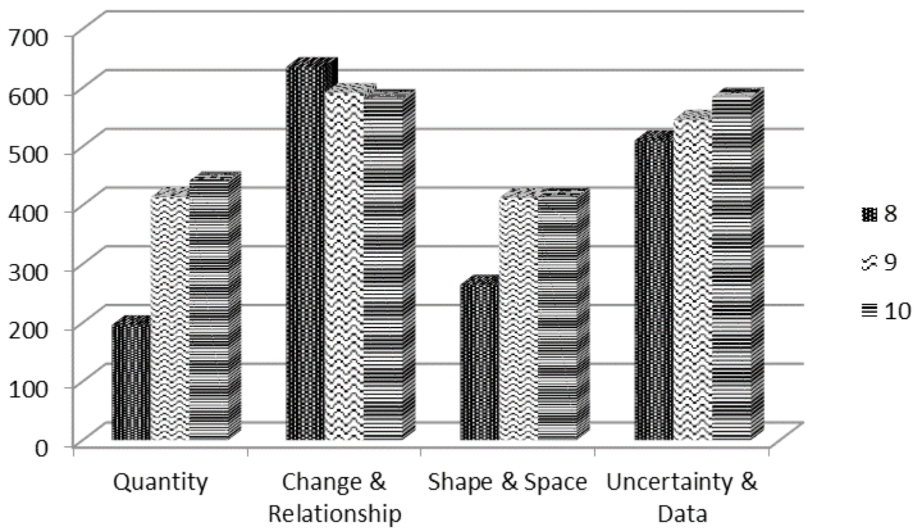
The participants' ability in accordance with the data analysis within the PISA model, the student ability scale should be transformed to a mean that was equal to 500 and the standard deviation that was equal to 100, minimum 0 and maximum 1,000. The results of the transformation were then categorized 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

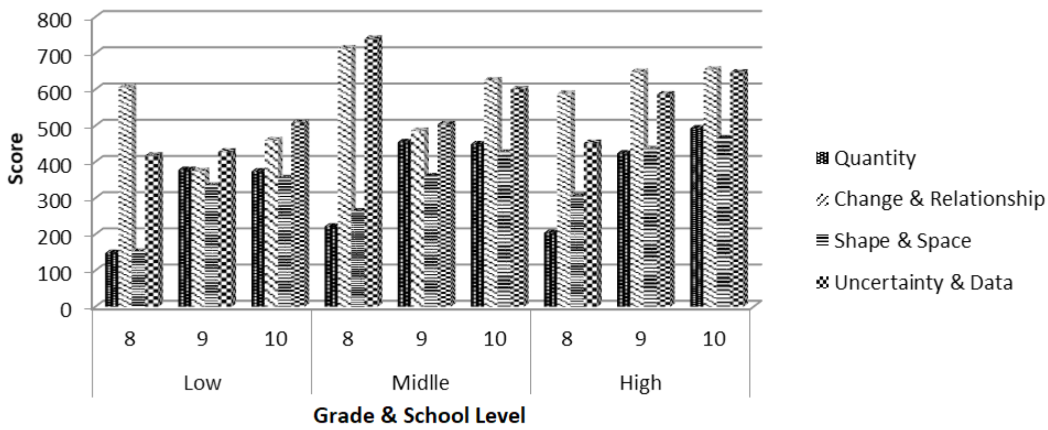
The mathematical literacy proficiency of the 10th grade students was better than that of the 8th and 9th grade students', particularly for the content of QNT, SS, and UD. The complete result is shown in Figure 1. This finding showed that there was an improvement on the 8th, 9th and 10th grade students' 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 showed that there was a decreasing on the students' mathematical literacy proficiency for the content of CR.

Figure 1
The mathematical literacy proficiency based on content



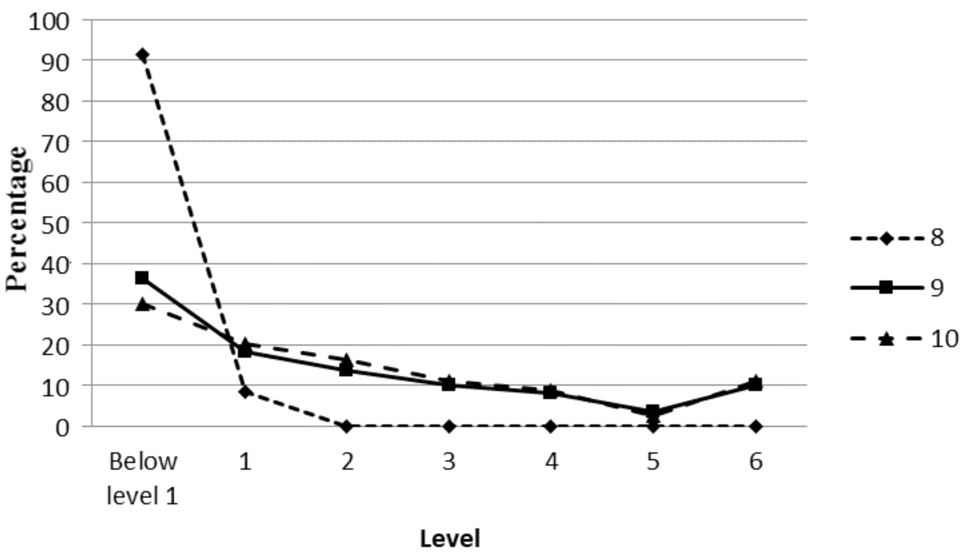
The growth of the students' mathematical literacy in the low school level improved among the 8th, 9th and 10th grade for the content of QNT, SS, UD. This result is shown in Figure 2. However, the highest score in CR was obtained by the 8th grade students. The growth of students' mathematical literacy 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, the Figure 2 shows that the literacy proficiency for the content of QNT increased from the 8th grade to the 9th grade but decreased from the 9th grade to the 10th grade. Similar result was obtained for the quantity content. 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.

Figure 2
The mathematical literacy proficiency based on content domain, grade 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.

Figure 3
The mathematical literacy on the content of QNT



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. These results are shown in Figure 3.

Figure 4
The level of mathematical literacy proficiency on the content of CR

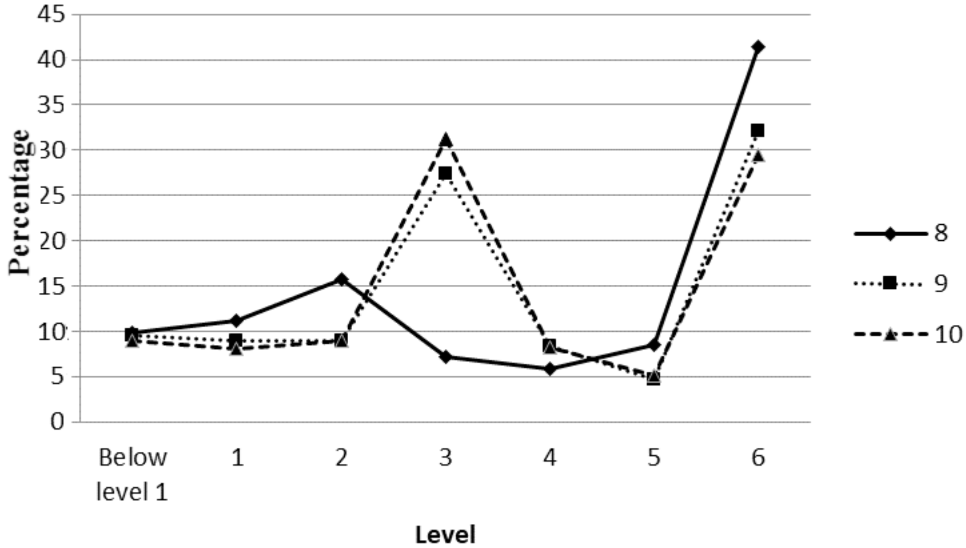
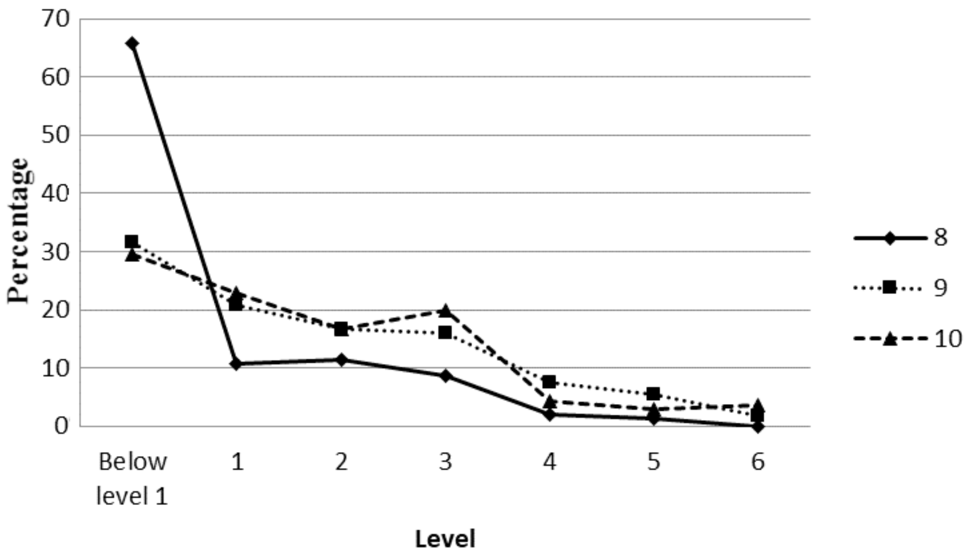


Figure 4 shows that base on the students' grade, the mathematical literacy proficiency for the content of a CR tended to be unstable. However, there were many 8th grade students who were in the "Level 6" category compared to the 9th and 10th grade students. This result might be due to the fact that the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

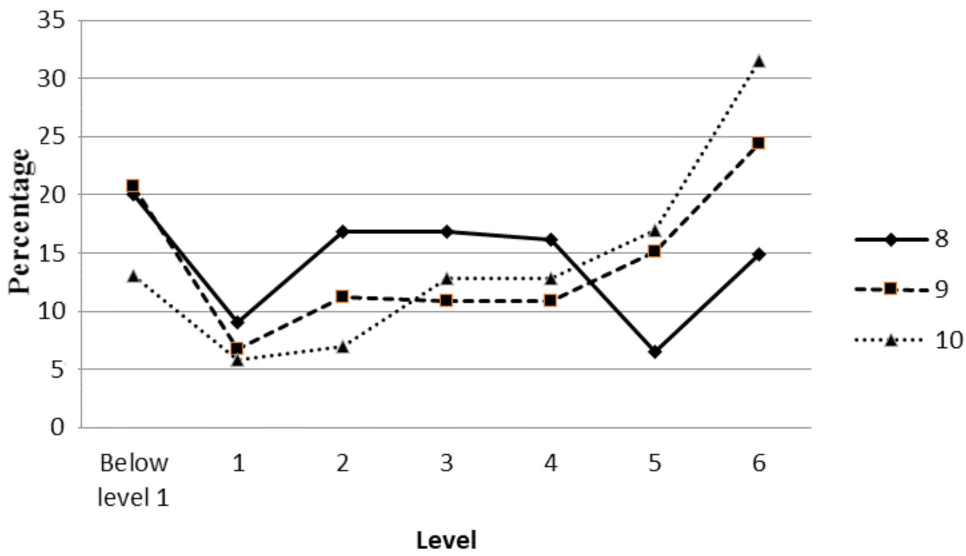
Figure 5
The level of mathematical literacy proficiency on the content of SS



Another content that became the focus of assessment in the mathematical literacy proficiency was the content of SS. Figure 5 shows 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 was low because most of the students achieved the below level 1–level 3 category. Figure 6 shows that the growth of mathematical literacy proficiency for the content of UD from the 8th grade students until the 10th grade students improved.

Figure 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 Figure 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.

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).

Figure 7
The mathematical literacy proficiency based on the Context

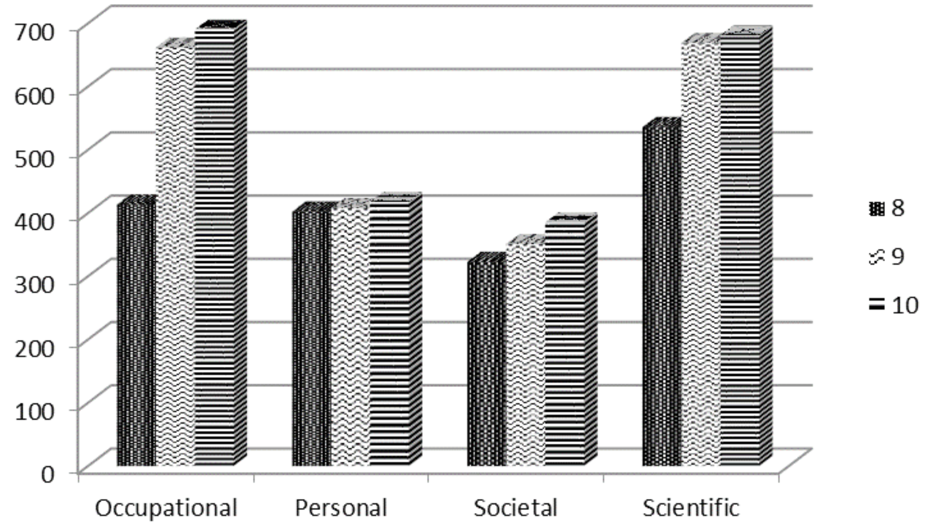
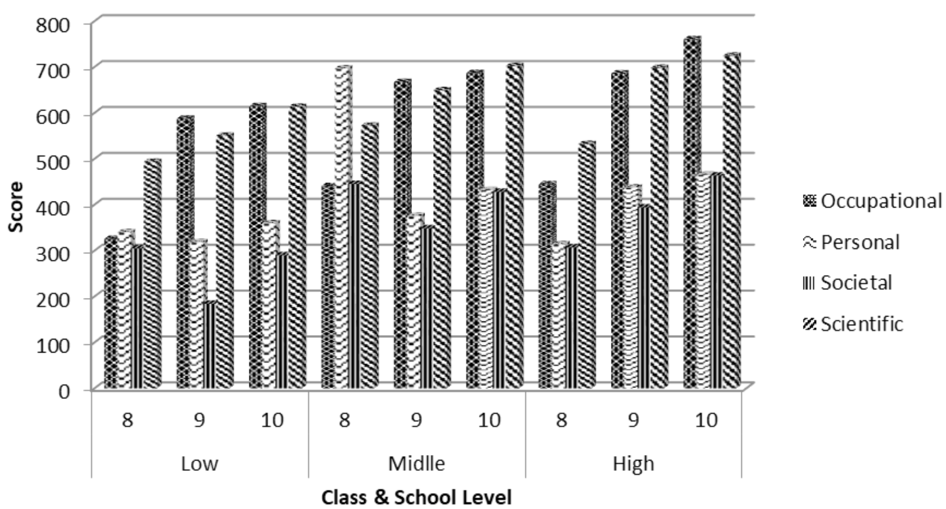


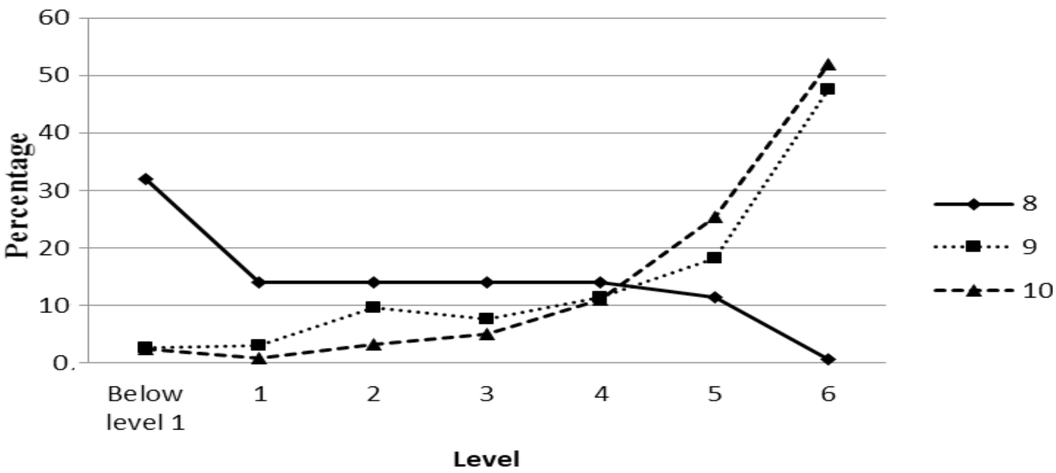
Figure 8 shows that the students' mathematical literacy proficiency in the low, moderate, and the high school level increased from the 8th grade to the 9th grade and from the 9th to the 10th grade for the OCC and SC context. On the contrary, the students' mathematical literacy proficiency for the PER 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.

Figure 8
Mathematical literacy proficiency based on the context, grade and the school level



Subsequently, the growth of the students' mathematical literacy proficiency based on each context is shown in Figure 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.

Figure 9
The Level of mathematical literacy proficiency on the OCC context



The results shown in Figure 9 suggest 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 Figure 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 Figure 10.

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Figure 10
The level of mathematical literacy proficiency on the per context

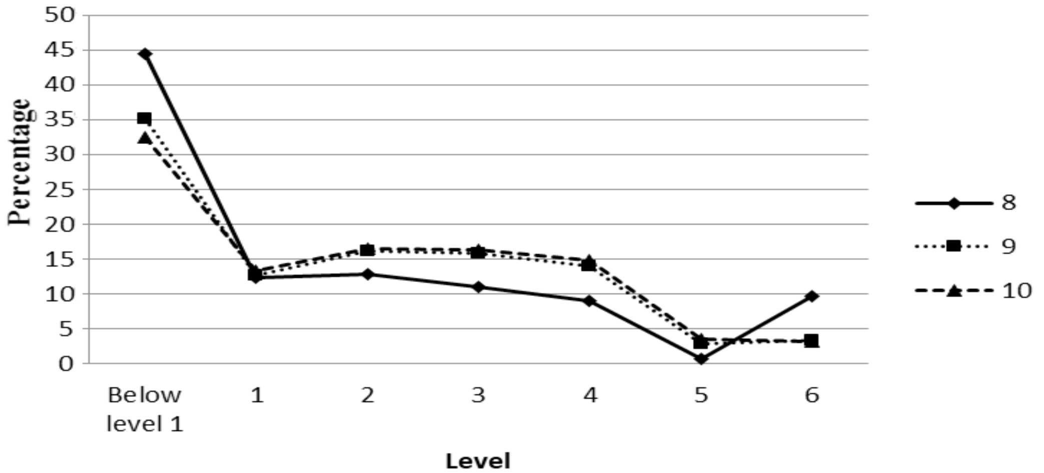
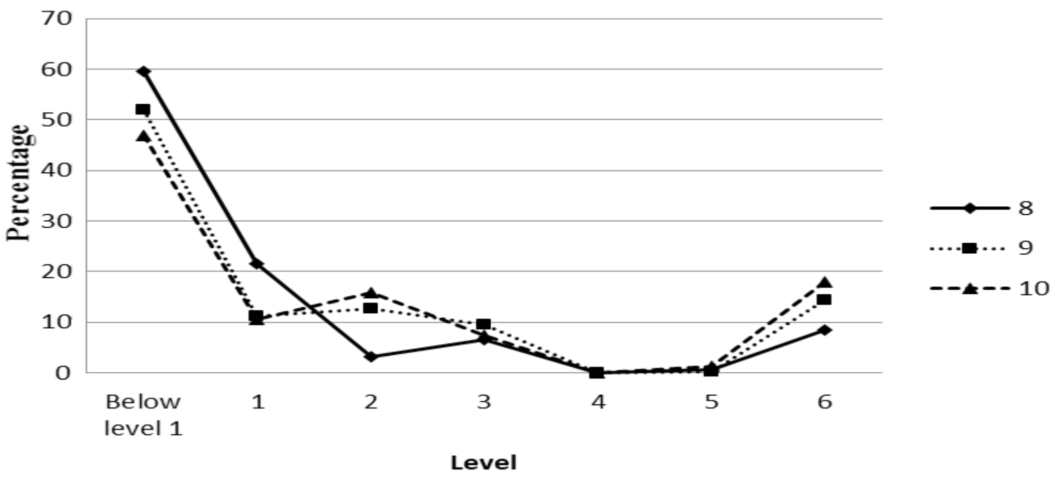


Figure 10 shows that for the PER context 30% of the 8th, the 9th and the 10th grade students were in "Below Level 1" category and 10% of the 8th, the 9th and the 10th grade students were in "Level 1" category. In addition, still based on the above Figure 10 it was apparent that the students' mathematical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

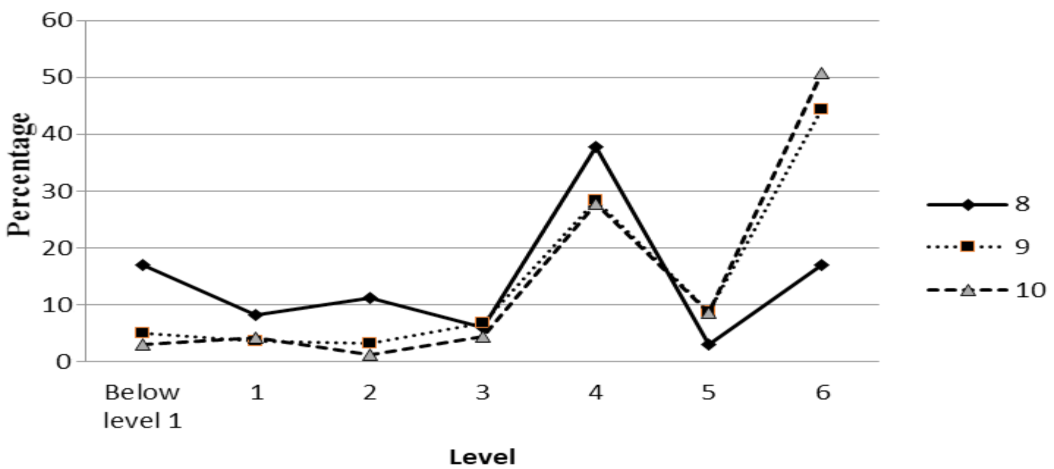
Figure 11
The level of mathematical literacy proficiency on the soc context



The SOC context was related to the use of mathematical knowledge in the SOC life and the wider neighborhood in the daily life. Figure 11 shows that the growth of the students' mathematical literacy proficiency was based on the SOC context. Figure 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 were more abstract and that demanded theoretical mastery and understanding in performing the mathematical problem solution (see Figure 12). For the SC context, Figure 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.

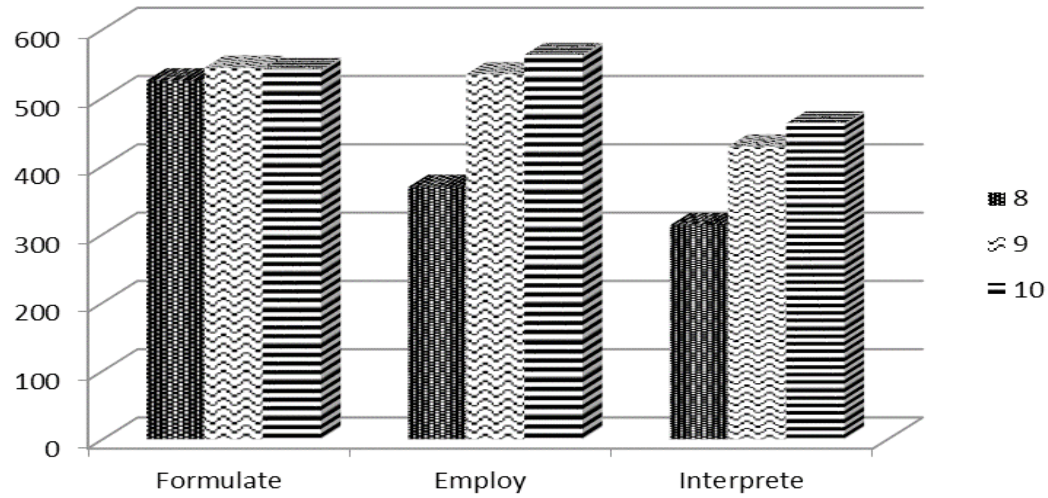
Figure 12
The level of mathematical literacy proficiency on the SC context



Literacy Proficiency Based on the Process

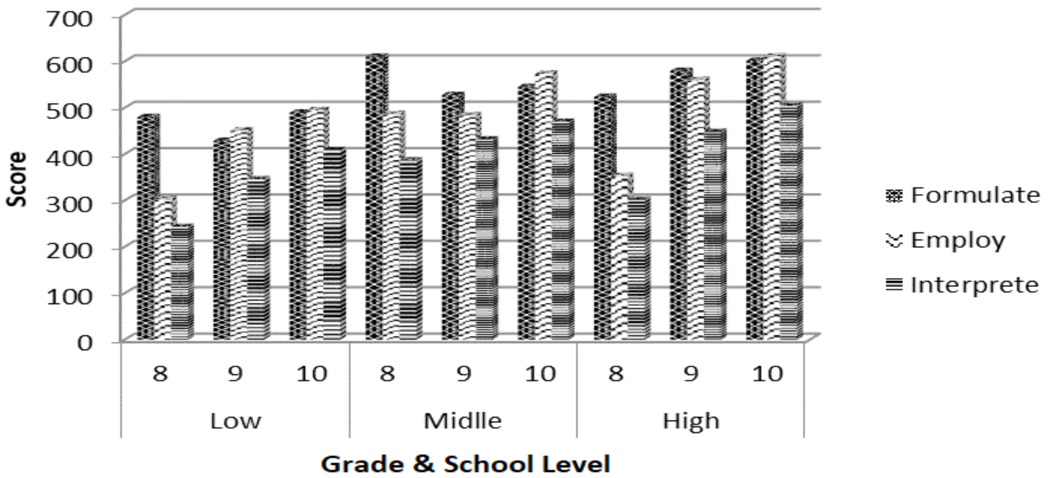
The students' literacy proficiency was also classified into each domain of process. The mapping of the 8th, 9th and 10th grade students' mathematical literacy proficiency in the domain of process is presented in Figure 13.

Figure 13
Mathematical literacy proficiency based on grade and process



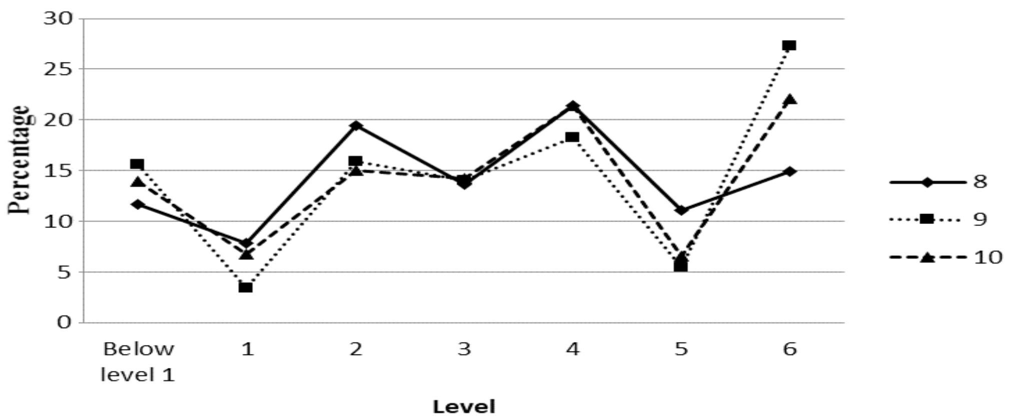
The domain of process in formulating the mathematical situations (formulate) the mathematical literacy proficiency of 8th, 9th and 10th grade of the students improved along with their grade level shown in Figure 13. Similar finding was also found in the domain of employing the mathematical concepts, 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.

Figure 14
The mathematical literacy proficiency based on process and school level



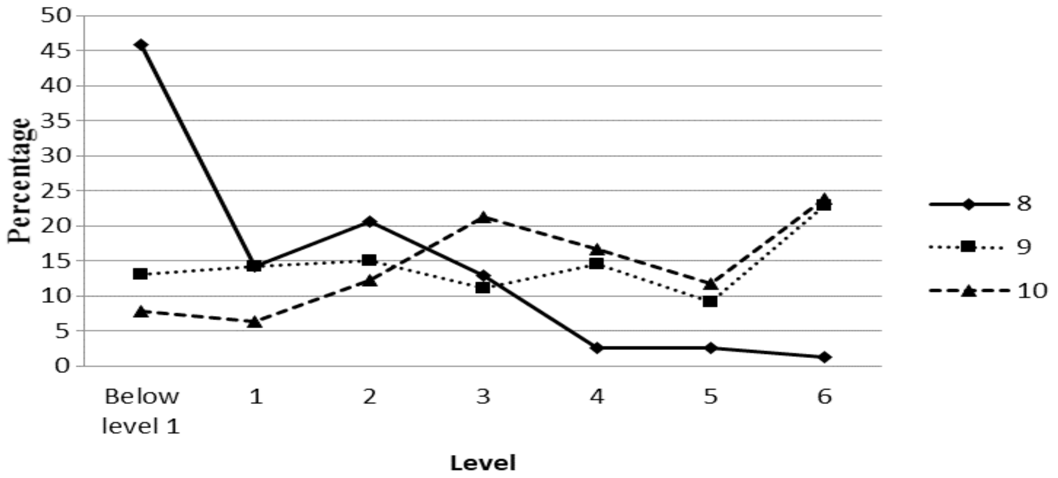
In addition to the domain of process, the growth of the students' mathematical literacy observed by the school level (i.e., low, moderate and high). The growth of the students' mathematical literacy proficiency for the domain of process in each school level is presented in Figure 14. The result in Figure 14 shows 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.

Figure 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 is shown in Figure 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 shown in Figure 16.

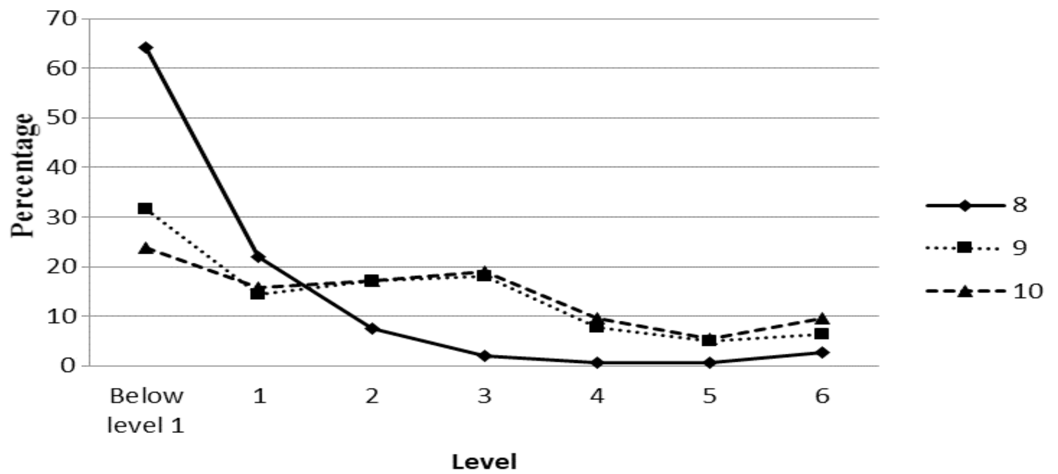
Figure 16
The mathematical literacy proficiency to employ



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. Figure 17 presents the mathematical literacy proficiency of the students' in the Province of Yogyakarta Special Region on the third domain of process.

Figure 17
The mathematical literacy proficiency to interpret



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

Discussion

The results of this research showed that there was an improvement of mathematical literacy proficiency of the 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, and Nordin (2011), and also Thoren, Heinig, and 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, and Liu (2008), and Novak and 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, and Obi (2015, p. 99); Josiah and 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 in 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 two 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 and Meerah (2010, p. 150) also found that students found difficulties during making meaningful connection in the problem. Furthermore, Jupri, Drijvers, and Heuvel-Panhuizen (2014, p. 51); Hadi, Retnawati, Munadi, Apino, and Wulandari (2018) also found that students experienced difficulties in solving problems due to their inability in applying the reverse strategy 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, and Ali (2015, p. 140), and Lieven, Fien, & Erik (2015) when they had to answer questions related to contexts that they have not learned before. Jailani, Sugiman, and Apino (2017) 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 heard by school that had high achievement. These findings had been in accordance with the findings from Bohlmann and Pretorius (2008), and also Chowa et al. (2015) that school-level characteristics affect academic achievement. There were many factors which 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 content in every grade. The content of CR and of uncertainty dominated the contents in the 8th grade and the 9th grade in Indonesian Curriculum.

The research results showed that the students' mathematical literacy was unsatisfying. It should 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 the 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 (Apino & Retnawati, 2017; 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.

Conclusions and Implications

In the content domain, specifically Shape and Space (SS), Quantity (QNT), and Uncertainty and Data (UD), there was progress from 8th grade to 9th, from 9th grade to 10th grade, but in Change and Relationship (CR), the ability of students from 8th grade was higher than students from 9th grade and 10th grade. The percentage of students whose literacy proficiency was in categories 1-6 in 9th grade and 10th grade tends to be higher than in 8th grade, and for 8th grade was dominant in below level 1. For CR and UD, the average ability of students was approaching 600. In the context domain, the literacy ability of students in occupational and scientific contexts showed the average of students' ability in 8th, 9th, and 10th grade was relatively similar. In the personal and societal context domains, the ability of students in grades 8th, 9th, and 10th was relatively the same. For the 8th grade, students' mathematical literacy abilities related to occupational and scientific contexts were already above the international average in grades 9 and 10 that met 600. In the process domain, the development of students' abilities on formulate (FRM) showed relatively the same results for 8th, 9th, and 10th were around 500. In the employ and interpret process domain, there was a development of abilities from 8th to 9th, and from 9th to 10th grade.

Based on the results of these studies, some further research can be conducted related to this research. The development of mathematical literacy abilities based on content, contexts and processes domains that have not been as expected, needs to be determined. The decreasing scores of students' literacy skills from 8th to 9th grade, from 9th to 10th grade also need to be known as the contributing factors. The results of students' literacy scores in the domain of content, context and processes that have not reached optimal scores, efforts to improve the quality of mathematics learning need to be done. Research related to improve teaching and learning that train mathematical literacy competencies, especially related to each mathematical literacy subdomain needs to be done. The assessment model to assess the development of student literacy skills for each domain also needs to be examined, so that the mathematical literacy ability of each stage can be measured. Likewise, students' difficulties in solving problems related to mathematical literacy skills also need to be described and planned how to cover it.

References

Abdullah, A. H., Abidin, N. L. Z., & Ali, M. (2015). Analysis of students' errors in solving higher order thinking skills (HOTS) problems for the topic of fraction. *Asian Social Science*, *11*(21), 133–142. https://doi.org/10.5539/ass.v11n21p133

Lieven, V., Fien, D., & Erik, D. C. (2015). Mathematics education. In J. D. Wright (Ed.), *International Encyclopedia of the Social & Behavioral Sciences* (Vol. 2, pp. 816–821). Oxford, UK: Elsevier. https://doi.org/10.1016/B978-0-08-097086-8.92048-8

Apino, E., & Retnawati, H. (2017). Developing instructional design to improve mathematical higher order thinking skills of students. *Journal of Physics: Conference Series, 812*(1), 1–7. https://doi.org/10.1088/1742-6596/812/1/012100

Atsnan, M. F., Gazali, R. Y., & Nareki, M. L. (2018). Pengaruh pendekatan problem solving terhadap kemampuan representasi dan literasi matematis siswa [The effect of the problem-solving approach on students' mathematical and literacy abilities]. *Jurnal Riset Pendidikan Matematika, 5*(2), 135-146. https://doi.org/10.21831/jrpm.v5i2.20120

Balitbang Kemdikbud RI. (2014). *Laporan hasil ujian nasional 2014*. [Research and Development Board, Ministry of Education, Republik Indonesia. (2014). Report of National Examination 2014] [Software].

Balitbang Kemdikbud RI. (2015). *Laporan hasil ujian nasional 2015*. [Research and Development Board, Ministry of Education, Republik Indonesia. (2015). Report of National Examination 2015] [Software].

Bohlmann, C., & Pretorius, E. (2008). Relationships between mathematics and literacy: exploring some underlying factors. *Pythagoras*, *67*(June), 42–55. https://doi.org/10.4102/pythagoras.v0i67.73

Casey, G. (2013). Interdisciplinary literacy through social media in the mathematics classroom: An action research study. *Journal of Adolescent & Adult Literacy*, *57*(1), 60–71. https://doi.org/10.1002/jaal.216

Chowa, G. A. N., Masa, R. D., Ramos, Y., & Ansong, D. (2015). How do student and school characteristics influence youth academic achievement in Ghana? a hierarchical linear modeling of Ghana youth save baseline data. *International Journal of Educational Development*, *45*, 129–140. https://doi.org/10.1016/j.ijedudev.2015.09.009

Djidu, H., & Retnawati, H. (2018). Cultural values-integrated mathematical learning model to develop HOTS and character values. In E. Retnowati, A. Ghufron, Marzuki, Kasiyan, A. C. Pierawan, & Ashadi (Eds.), *Character education for 21st century global citizens* (pp. 363–370). Routledge. https://doi.org/10.1201/9781315104188-46

Drew, S. V. (2012). Open up the ceiling on the common core state standards: preparing students for 21st-century literacy-now. *Journal of Adolescent & Adult Literacy*, *56*(4), 321–330. https://doi.org/10.1002/JAAL.00145

Eze, T. I., Ezenwafor, J. I., & Obi, M. N. (2015). Effects of age and gender on academic achievement of vocational and technical education (VTE) students of a Nigerian university. *Journal of Emerging Trends in Educational Research and Policy Studies*, *6*(1), 96–101.

Hadi, S., Retnawati, H., Munadi, S., Apino, E., & Wulandari, N. F. (2018). The difficulties of high school students in solving higher-order thinking skills problems. *Problems of Education in the 21st Century, 76*(4), 520–532.

Hambleton, R. K., & Swaminathan, H. (1985). *Item response theory*. Kluwer.

Hannafin, R. D., Truxaw, M. P., Vermillion, J. R., & Liu, Y. (2008). Effects of spatial ability and instructional program on geometry achievement. *The Journal of Educational Research*, *101*(3), 148–157. https://doi.org/10.3200/JOER.101.3.148-157

Hillman, A. M. (2014). A Literature review on disciplinary literacy. *Journal of Adolescent & Adult Literacy*, *57*(5), 397–406. https://doi.org/10.1002/jaal.256

Jabor, M. K., Machtmes, K., Kungu, K., Buntat, Y., & Nordin, M. S. (2011). The influence of age and gender on the students' achievement in mathematics. *2011 International Conference on Social Science and Humanity*, *5*, 304–308.

Jailani, J., Retnawati, H., Musfiqi, S., & Wulandari, N. F. (2015). Pengembangan perangkat pembelajaran matematika berbasis HOTS dan pendidikan karakter [The development of mathematics teaching material based on Higher Order Thinking Skills (HOTS) and character education]. *Laporan Penelitian Universitas Negeri Yogyakarta* [*Research Report of Yogyakarta State University*], Indonesia.

Jailani, J., Sugiman, S., & Apino, E. (2017). Implementing the problem-based learning in order to improve the students' HOTS and characters. *Jurnal Riset Pendidikan Matematika [Journal of Mathematics Education Research], 4*(2), 247-259. http://dx.doi.org/10.21831/jrpm.v4i2.17674

Josiah, O., & Adejoke, E. O. (2014). Effect of gender, age and mathematics anxiety on college students' achievement in algebra. *American Journal of Educational Research*, *2*(7), 474–476. https://doi.org/10.12691/education-2-7-7

Jupri, A., Drijvers, P., & Heuvel-Panhuizen, M. Van den. (2014). Student difficulties in solving equations from an operational and a structural perspective. *International Electronic Journal of Mathematics Education*, *9*(1), 39–55.

Kartianom, K., & Ndayizeye, O. (2017). What's wrong with the Asian and African students' mathematics learning achievement? The multilevel PISA 2015 data analysis for Indonesia, Japan, and Algeria. *Jurnal Riset Pendidikan Matematika [Journal of Mathematics Education],, 4*(2), 200-210. http://dx.doi.org/10.21831/jrpm.v4i2.16931

Krasny, K. A. (2013). *Gender and literacy: A handbook for educators and parents*. Santa Barbara, CA: ABC-CLIO, LLC All.

Magen-Nagar, N. (2016). The effects of learning strategies on mathematical literacy: A comparison between lower and higher achieving countries. *International Journal of Research in Education and Science*, *2*(2), 306–321.

Masters, G. N. (2010). The partial credit model. In W. J. van der Linden (Ed.), *Handbook of item response theory models* (pp. 109–122). Routlegde.

Matute, E., Montiel, T., Pinto, N., Rosselli, M., Ardila, A., & Zarabozo, D. (2012). Comparing cognitive performance in illiterate and literate children. *International Review of Education*, *58*(1), 109–127. https://doi.org/10.1007/s11159-012-9273-9

NCCA. (2012). *Project maths: Responding to current debate*. National Council for Curriculum and Assessment. http://www.ncca.ie/en/Publications/Other_Publications/Project-Maths-Responding-to-Current-Debate.pdf

Novak, E., & Tassell, J. L. (2017). Studying preservice teacher math anxiety and mathematics performance in geometry, word, and non-word problem solving. *Learning and Individual Differences*, *54*, 20–29. https://doi.org/10.1016/j.lindif.2017.01.005

OECD. (2006). *Assessing scientific, reading and mathematical literacy*. OECD Publishing. https://doi.org/10.1787/9789264026407-en

OECD. (2016). *PISA 2015 results (Volume I): Excellence and equity in education*. OECD Publishing. https://doi.org/10.1787/9789264266490-en

OECD. (2017). *PISA 2015 assessment and analytical framework: Science, reading, mathematics, financial literacy and collaborative problem solving*. OECD Publishing. https://doi.org/10.1787/9789264281820-en

Ojose, B. (2011). Mathematics literacy: Are we able to put the mathematics we learn into everyday use? *Journal of Mathematics Education*, *4*(1), 89–100.

Retnawati, H., Djidu, H., Kartianom, K., Apino, E., & Anazifa, R. D. (2018). Teachers' knowledge about higher-order thinking skills and its learning strategy. *Problem of Education in the 21st Century*, *76*(2), 215–230. http://oaji.net/articles/2017/457-1524597598.pdf

Retnawati, H., & Wulandari, N. F. (2019). The development of students' mathematical literacy proficiency. *Problems of Education in the 21st Century*, *77*(4), 502–514. https://doi.org/10.33225/pec/19.77.502

Savaş, E., Taş, S., & Duru, A. (2010). Factors affecting students' achievement in mathematics. *Inonu University Journal of the Faculty of Education*, *11*(1), 113–132.

Shiel, G., Perkins, R., Close, S., & Oldham, E. (2007). *PISA mathematics: a teacher's guide*. Dublin: Department of Education and Science.

Stacey, K. (2011). The PISA view of mathematical literacy in Indonesia. *Indonesian Mathematical Society Journal on Mathematics Education*, *2*(2), 95–126. https://doi.org/10.22342/jme.2.2.746.95-126

Tambychik, T., & Meerah, T. S. M. (2010). Students' difficulties in mathematics problem-solving: What do they say? *Procedia - Social and Behavioral Sciences*, *8*(5), 142–151. https://doi.org/10.1016/j.sbspro.2010.12.020

Thoren, K., Heinig, E., & Brunner, M. (2016). Relative age effects in mathematics and reading: investigating the generalizability across students, time and classes. *Frontiers in Psychology*, *7*, 1-12. Article 679. https://doi.org/10.3389/fpsyg.2016.00679

Türkan, A., Üner, S. S., & Alcı, B. (2015). 2012 PISA matematik testi puanlarının bazı Değişkenler Açısından İncelenmesi [An analysis of 2012 PISA mathematics test scores in terms of some variables]. *Ege Eğitim Dergisi*, *16*(2), 358–372.

UNESCO. (2015). *Education for all 2000-2015: achievements and challenges*. *EFA Global Monitoring Report* (2nd ed.). UNESCO Publishing.

Uysal, Ş. (2015). Factors affecting the mathematics achievement of Turkish students in PISA 2012. *Educational Research and Reviews*, *10*(12), 1670–1678. https://doi.org/10.5897/ERR2014.2067

Wu, M. L., Adams, R. J., & Wilson, M. R. (1997). *ConQuest: Multi-aspect test software*. Australian Council for Educational Research.

Yavuz, H. Ç., İlgün Dibek, M., & Yalçın, S. (2017). Türk ve Vietnamlı öğrencilerin PISA 2012 matematik okuryazarlığı ile dürtü ve güdülenme özellikleri arasındaki ilişkiler [Relationship between drive and motivation features and PISA 2012 mathematics literacy of Turkish and Vietnamese students]. *İlköğretim Online*, *16*(1), 178–196. https://doi.org/10.17051/io.2017.45107

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