Content Analysis of Students' Argumentation Based on Mathematical Literacy and Creation Ability

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Abstract: This study investigated the argumentation of 27 junior high school students in building their creative reasoning and the relationship between students' argumentation and their mathematical literacy skills. The data collected using mathematical literacy test and assessment rubric and were analyzed using qualitative content analysis. The study found that students tended to use simple statements than complex statements in explaining their mathematical arguments. Furthermore, the study also showed that students, in constructing their arguments, used syntax to support their problem-solving reasoning structure though it does not necessarily strengthen their correct final answer. Students with developed mathematical literacy skills tended to be creative in building their arguments, where they used not only statements but also pictures to strengthen their constructed problem-solving arguments.

INTRODUCTION

The ability of argumentation in learning mathematics is important in building students' mathematical abilities. Arguments are at the core of scientific thinking (Cross, 2009; Hidayat et al., 2018b) and knowledge in argumentation are also important for logical understanding and effective communication (Lin, 2018). Argumentation in mathematics is an important part of the discipline of mathematics and a key indicator of mathematical competence (Graham & Lesseig, 2018). In the process of building arguments and criticizing the reasoning of others, students develop their understanding of the underlying mathematical ideas and engage in critical thinking activities (Graham & Lesseig, 2018; Yackel & Hanna, 2003).

Arguments are commonly perceived as a statement expressing a viewpoint, backed by logical reasoning (Hidayat et al., 2018b). Viewpoints (Soekisno, 2015) describe arguments as a person's justification for addressing issues, problems, and debates. Argumentation aims to provide a solution to a problem, consisting of claims supported by different principles (assurances), evidence, and counterarguments (objections) (Hidayat et al., 2018b). Arguments are considered to be a result of the reasoning process. Therefore, it can be inferred that arguments arise from the process of reasoning (Dawson & Venville, 2010; Mercier & Sperber, 2013; Soekisno, 2015).

The ability of students to present mathematical arguments is supported by their creative motivation to provide logical and mathematical explanations to solve a given problem (Walter & Barros, 2011). Mathematical creativity is crucial for the growth of mathematics as a whole. Laycock (1970) defined mathematical creativity as the ability to approach a problem from different perspectives, recognize patterns, differences, and similarities, generate multiple ideas, and choose appropriate methods to tackle unfamiliar mathematical situations.

According to Poincaré (as cited in Nadjafikhah et al., 2012), mathematical creativity involves making useful combinations of ideas while avoiding useless ones. The focus on creativity is to encourage students to not only solve problems given to them but also generate creative ideas that can be used in their solutions and provide creative reasoning (Kozlowski et al., 2019).

In this context, creative reasoning refers to the thought process used to make statements and reach conclusions while solving problems. The reasoning is not always based on formal logic and may even be incorrect as long as there are plausible reasons to support it. The term "reasoning" is used broadly in this framework to include both high-quality and low-quality arguments, and the quality of the argument is evaluated separately. The data used in this investigation are behavioral data, and any underlying thought processes can only be speculated (Vinner, 1997).

Students aim to develop their reasoning skills through their mathematical literacy knowledge. Mathematical literacy is a necessary competency for students, encompassing abilities such as communication, representation, reasoning, and problem-solving strategies, among others (OECD, 2010; Nasrullah & Baharman, 2018). Despite this, students need to improve their use of mathematical literacy to solve problems effectively. The Organization for Economic Co-operation and Development (OECD) framework identifies seven mathematical abilities that comprise mathematical literacy, including critical and creative thinking, communication, and assessment. This framework highlights the importance of mathematical literacy in contemporary society, as it (OECD, 2016) is seen as being as significant as literacy.

Despite the fact that students struggle to develop these abilities, it's important to understand how they respond to using mathematical literacy skills, which are crucial not just for completing competencies but also for problem-solving. However, utilizing mathematical literacy is a challenging task as it requires a level of knowledge and awareness to link that knowledge to real-life phenomena, even though such phenomena can be used to motivate students to learn mathematics (Sembiring & Hadi, 2008). Therefore, given problems can serve as stimuli for students to enhance their mathematical literacy skills (Eerde & Van Galen, 2019).

Everyday life phenomena and contexts are fascinating and can be used to aid students in building their knowledge. However, teachers face difficulties in teaching mathematical literacy, as many still apply mechanistic mathematics learning in their classes (Bustang, 2022). Additionally, people may not comprehend the significance of studying mathematics in everyday life because the subject matter is often dominated by mathematical formulas and modeling.

Creating mathematical models actually originates from real-life situations and contexts. This is an important aspect of mathematics education and the development of mathematical literacy skills. To foster these skills, it is essential to connect students' knowledge with various contexts from their personal lives, communities, workplaces, and sciences.

Observations of school learning activities show that students lack opportunities to develop their mathematical literacy skills. These opportunities require allocated learning time, and are related to the process of how individuals acquire mathematical knowledge (Carroll, 1963; Cogan & Schmidt, 2015). Learning opportunities include various factors that affect teacher practices and student learning, such as content coverage and emphasis (Barnard-Brak et al., 2018). Building mathematical arguments requires both creative encouragement and emphasis on content (Stevens & Grymes, 1993). However, the learning outcomes achieved do not always result in improved learning outcomes. Therefore, it is important for teachers to provide structured reinforcement through learning activities that contain exercises to develop mathematical literacy skills. The study reported in this article sought to answer the following questions:

1. What is the content of students' arguments and what does an analysis of this content as well as the syntax used inform on their reasoning, specifically their concept development as they struggle to create, and communicate meaning for their responses?
2. Is there a relationship between the content of the argument and the mathematical literacy ability of students?

METHOD

This research is based on a descriptive qualitative method and involved 27 junior high school students from Toli-Toli City, Central Sulawesi, Indonesia. The students were provided with a mathematical literacy test that required them to provide explanations for their answers. The test was assessed using a rubric that included representation, interpretation, and argumentation as assessment indicators. For the content of the argumentation, qualitative content analysis was used to analyze the text data. Research using qualitative content analysis focuses on the characteristics of language as communication by paying attention to the content or contextual meaning of the text (Budd et al., 1967; Lindkvist, 1981; McTavish & Pirro, 1990; Tesch, 1990). Text data may be in verbal, printed, or electronic form and may be obtained from narrative responses, open-ended survey questions, interviews, focus groups, observations, or printed media such as articles, books, or manuals (Kondracki et al., 2002). Qualitative content analysis goes beyond simply counting words to intensively examine language with the aim of classifying large amounts of text into an efficient number of categories that represent the same meaning (Weber, 1990). This category can represent explicit communication or inferred communication. The aim of content analysis is “to provide knowledge and understanding of the phenomenon under study” (Downe-Wambodt, 1992). In this article, qualitative content analysis is defined as a research method for the subjective interpretation of text data content through a systematic classification process, coding and identifying themes or patterns.

This study conducts a content analysis by examining the argumentation keywords present in the responses provided by the students. The analysis identifies three types of keywords: simple statement keywords, complex statement keywords, and statement keywords with syntax. Simple statement keywords are the fundamental ideas that form the basis of the reasoning presented in the responses. If a keyword contains more than one important idea, it is referred to as a complex statement keyword. Additionally, some students use syntax, such as the "known-asked-answered" pattern, when constructing their arguments. If these statements contain fundamental ideas within the reasoning, they are classified as statement keywords with syntax.

RESULTS AND DISCUSSION

This section is divided into multiple parts which include 1) issues, 2) illustrations of student responses, and 3) a compilation of key argument statements. The explanations are presented as follows.

Problem

The image displays the Balre Masigi traditional house of Tolitoli, which is typically utilized for meetings of regional officials. Alongside the house, a garage for official vehicles is planned to be constructed, which will feature one door and one window.

Figure 1: House of Tolitoli (Balre Masigi)   Figure 2: Illustration of a garage

Using the images provided in figures 1 and 2, identify the matching picture of the garage building as seen from the back. Justify your selection.

Figure 3: Back view of a garage

Example of students' answers

Student's answers with incorrect simple statements

Based on the questions given, one of the student's answers which are included in the argument is a simple statement which is shown as follows.

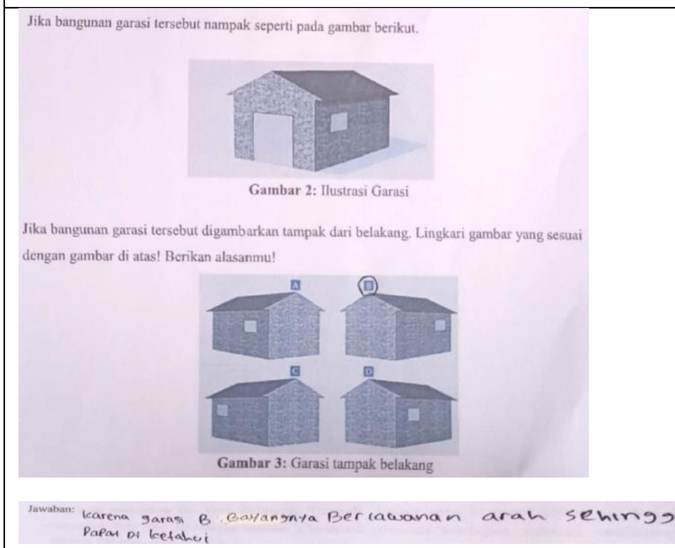
<table>
<tr><th>Student's Answers</th><th>Description</th></tr>
<tr><td>
</td><td>The student's reasoning is based on the observation that the shadow of the garage is cast in the opposite direction, indicating that the orientation of the garage is different from the house. Specifically, when viewed from behind, the garage should be on the right side of the house. Therefore, the student selected option B as the correct match.</td></tr>
</table>

Table 1: Example of student's answers with incorrect simple statements

Student's answers with correct simple statements

Based on the questions given, one of the student's answers which are included as correct with arguments in the form of simple statements is shown as follows.

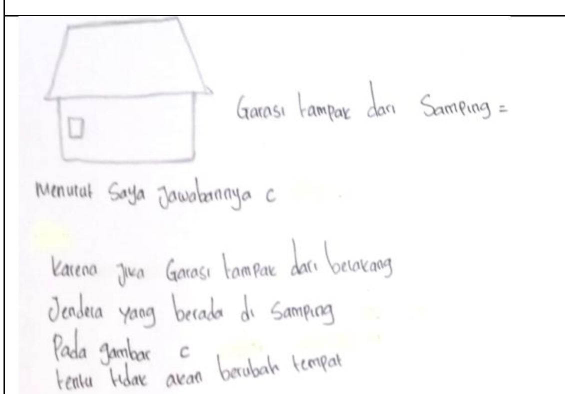
<table>
<tr><th>Student's Answers</th><th>Description</th></tr>
<tr><td>
</td><td>The student's answer argues that the correct option is C because the window on the side in picture C remains in the same position when viewed from the back. The argument is based on the location of the window, and the student first describes the position of the garage from the side to strengthen their argument.</td></tr>
</table>

Table 2: Examples of student's answers with correct simple statements

Student's answers with correct complex statements

Based on the questions given, one of the student's answers which is included is correct with an argument in the form of a complex statement is shown as follows.

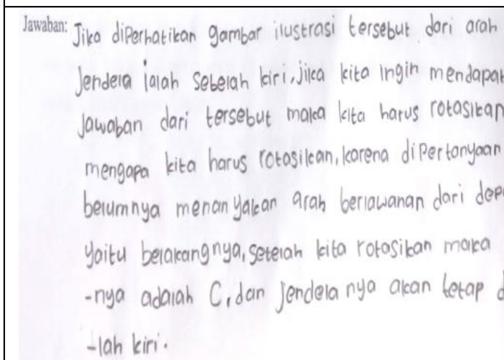
Student' Answers	Description
 Jawaban: Jika diperhatikan gambar ilustrasi tersebut dari arah jendela ialah sebelah kiri, jika kita ingin mendapat jawaban dari tersebut maka kita harus rotasikan mengapa kita harus rotasikan, karena dipertanyaan belumnya menanyakan arah berlawanan dari dep yaitu belakangnya, setelah kita rotasikan maka -nya adalah C, dan jendelanya akan tetap d -lah kiri.	The student's argument in this answer involves not only the window's location but also the concept of rotation. The student notes that the previous question asked for the opposite direction from the front, which is the back. To obtain an answer, the student suggests rotating the illustration. After the rotation, the window remains on the left, leading to answer C. The concept of rotation is relevant to the problem because it addresses the requirement to consider the opposite direction.

Table 3: Examples of student's answers with correct complex statements

Student's answers with incorrect syntax statements

Based on the questions given, one of the student's answers which was included as an argument was in the form of a statement equipped with syntax as in Table 4.

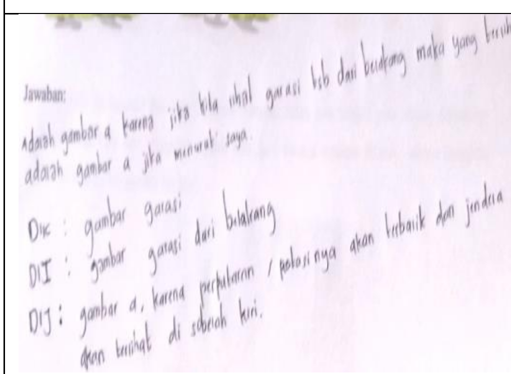
Student' Answers	Description
 Jawaban: adalah gambar a karena jika kita lihat garasi tsb dari belakang maka yang terlih adalah gambar a jika menurut saya. Dik : gambar garasi DIT : gambar garasi dari belakang DIJ : gambar a, karena perputaran / rotasinya akan terbalik dan jendela akan terlihat di sebelah kiri.	The student's argument in their answer is that the garage in image A is the one that would be seen when viewed from behind. Known: garage drawing Question: Picture of the garage from behind Solution: Picture a, because the rotation will be reversed, and the window will be visible on the left. The syntax used in building the argument is based on the Known, Asked, and Answered stages, which are seen as steps in preparing arguments. The argument used in this case involves a complex concept, which not only considers the window's location but also the idea of rotating or turning the object. However, the interpretation of the object's rotation does not necessarily support the correctness of the chosen answer.

Table 4: Examples of student's answers with incorrect syntax statements

Student's answers with correct syntax statements

One of the answers provided by a student is deemed correct based on the given questions, and the argument provided is presented in the form of a statement accompanied by syntax.

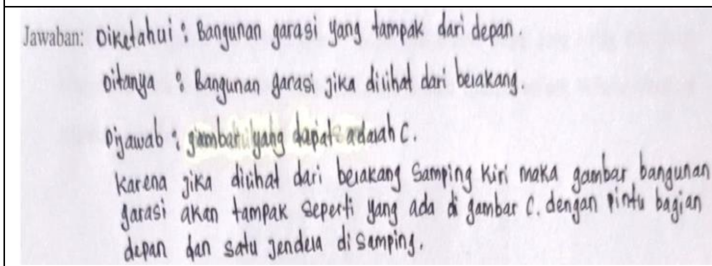
Student' Answers	Description
 Jawaban: Diketahui : Bangunan garasi yang tampak dari depan. Ditanya : Bangunan garasi jika dilihat dari belakang. Dijawab : gambar yang dapat adalah C. Karena jika dilihat dari belakang Samping Kiri maka gambar bangunan garasi akan tampak seperti yang ada di gambar C. dengan pintu bagian depan dan satu jendela di samping.	Known: Garage building as seen from the front Question: Garage building when viewed from behind Solution: the right picture is C. Because if you look at it from the back on the left, the garage building will look like the one in picture c. With a front door and a side window. The syntax used in constructing arguments includes the stages of Known, Asked, and Answered. The argument is based on a complex concept that involves not only the window location but also the rotation of the object. However, the interpretation of the object's rotation does not support the correct answer.

Table 5: Examples of student answers with correct syntax statements

A collection of core arguments

The study identified four groups of presentations based on the collected data: 1) answers with no argumentative statement, 2) answers with simple statement keywords, 3) answers with complex statement keywords, and 4) answers with keyword statements arranged through syntax. It is noteworthy that two students did not provide any reasoning in their answers, despite one of them getting the right answer while the other got the wrong answer. Although it is not clear how one of the students arrived at the correct answer without providing any reasoning, it is possible that their surroundings may have played a supportive role.

Simple statement

For simple statement keywords, a collection of statements put forward by students is shown in the table as follows.

No	Statement	Respond
1	• Place windows • Viewed from behind • Looking back • Position windows by direction • Location of windows, from the front of the window in front • Window position from the front and from the back • Window shape and location • A, B, D do not match if the photo is from behind • The location of the window determines the image from the back • Decisive window • Image C is correct when photographed from behind and photos A, B, D are not correct when photographed from behind • Looking at the garage from behind, windows visible from behind	Correct Answer
2	• The shadow is in the opposite direction	Incorrect Answer

Table 6: Simple statement keywords

Table 6 shows that students presented 13 variations of statements in constructing their answers. One of the statements directed the students by stating "The image is in the opposite direction". However, the chosen answer was not correct or as expected, indicating that the arguments built were not in line with the context of the picture. This reflects the students' weak mathematical literacy skills, particularly in reading and communicating information to draw accurate conclusions.

According to the data in the table, there were 12 variations of statements used by students in constructing their arguments to support their chosen answer. Two forms of ideas were identified from these statements: 1) referencing the location or position of the window, and 2) testing the answer choices based on the location or position of the window. These strategies were used by students to arrive at the correct answer.

Complex Statement

For complex statement keywords, a collection of statements put forward by students is shown in the table as follows.

No	Statement	Respond
1	• Front view and back view • Window front direction, rotate, opposite direction • View from the rear, rotates 180^0, the window moves to the front on the left • Using pictures for representation, the garage seen from behind the side window	Correct Answer

Table 7: Complex statement keywords

Table 7 displays the results of student work, which revealed that all answers were correct and met the expectations. The complexity of student responses can be attributed to the concepts of orientation, rotation, and visualization used, such as considering the perspective from multiple sides, understanding direction and rotation, and considering image representation, view, and position. The ability of students to provide logical reasoning and make appropriate decisions based on the information provided demonstrates that their mathematical literacy skills vary, with some students being more proficient than others.

Statements with Syntax

While it is not uncommon for students to use syntax when solving mathematical problems, it appears that the syntax pattern of Known, Asked, and Answered is commonly used in the mathematics learning they follow. This pattern of steps is used to solve the given problem, but only a few students use it in their answers to this particular problem. When constructing their answers, they formulate the statement in the following form.

Table 8 presents the results of analyzing student answers using the syntax approach, and it was found that one student provided an incorrect answer. Despite using the concepts of orientation and rotation, the student's answer was not presented in a clear and hierarchical manner. On the other hand, other students who provided the correct answer used a more structured and organized syntax, mainly based on the concept of orientation from two different sides. Their argumentation and reasoning were also strong and supported their answer choice.

Based on the explanation stated above, various arguments built by students involving various mathematical concepts show the progress of their way of thinking. By placing some mathematical concepts in the construction of solving these problems, it is their way of being creative to achieve the targeted goals (Poincaré, as cited in Nadjafikhah et al., 2012), such as making pictures or making an overview of how to view the garage building from various directions or positions. This combination is a creation that is used to solve a given problem, but also offers creative ideas that are used in creative arguments (Hidayat et al., 2018a).

It seems that spatial reasoning (holistic, analytic and pattern-based) (Hsi et al., 1997) was used in the construction of the solution, although analytic and pattern-based spatial reasoning was not well developed. In general, students' ability to utilize holistic spatial reasoning can be seen from the way they interpret a given mathematical literacy problem. In other words, students can interpret the problem well if it is supported by mathematical literacy skills which also develop well following the given problem, although it was found that 2 students did not show the argumentation ability well.

No	Statement	Respond
1	• Front view and back view (Arranged with known, asked, and answered patterns) • Seen from the rear left side, the picture of the garage building will look like picture C, the front door and one side window (Arranged with known, asked, and answered patterns) • The garage building that is visible from the back because of the location of the window from the front on the left after behind the garage it appears that the window has moved to the right because it is viewed from behind (Arranged with known, asked, and answered patterns)	Correct Answer
2	• Viewed from behind, the rotation will be reversed, and the window is visible on the left (Arranged with known, asked, and answered patterns)	Incorrect Answer

Table 8: Keyword statements with syntax

However, if it is seen from what has been shown by students in their work, the ability of students to argue using complex statements is able to demonstrate the mathematical concepts used to obtain the correct answer. Meanwhile, the use of syntax in constructing answers does not ensure that students can get the correct answer as expected. In this problem, the use of simple statements is more used than complex statements and statements using syntax. The variety in constructing the answer cannot be separated from factors or dimensions or moments that do not change, such as cultural or habitual, social, and even individual factors (García et al., 2006).

Based on this review, several skill-oriented transformations toward a problem-based reform approach (Sembiring & Hadi, 2008), in the form of mathematical literacy problems are intended to highlight mathematical skills and understanding that are useful in future life so that they are used as preparation for using mathematics in learning high-level technical profession (Stacey, 2011).

CONCLUSIONS

Based on the results of the research presented above, some conclusions are obtained as follows, 1) Students use simple statements more than complex statements in building mathematical arguments, 2) In building arguments, students use syntax to support problem solving reasoning structures even though does not necessarily strengthen the correct final answer, and 3) Students who develop mathematical literacy skills can be creative by building their arguments not only with statements, but also through pictures to strengthen the constructed problem-solving arguments.

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References

[1] Barnard-Brak, L., Lan, W. Y., & Yang, Z. (2018). Differences in mathematics achievement according to opportunity to learn: A 4pL item response theory examination. *Studies in Educational Evaluation, 56*, 1–7.

[2] Budd, R. W., Thorp, R. K., & Donohew, L. (1967). Content analysis of communications. London, Macmillan.

[3] Bustang, B. (2022). Probability conceptions and metacognitive judgements of Indonesian secondary school students and in-service mathematics teachers. [Unpublished doctoral dissertation]. Loughborough University.

[4] Carroll, J. (1963). A model of school learning. Teachers College Record, 64(8), 723-733.

[5] Cogan, L. S., & Schmidt, W. H. (2015). The concept of opportunity to learn (OTL) in international comparisons of education. In K. Stacey & R. Turner (Eds.), *Assessing Mathematical Literacy* (pp. 207–216). Cham: Springer.

[6] Cross, D. I. (2009). Creating optimal mathematics learning environments: Combining argumentation and writing to enhance achievement. *International Journal of Science and Mathematics Education, 7*(5), 905–930. https://doi.org/10.1007/s10763-008-9144-9

[7] Dawson, V. M., & Venville, G. (2010). Teaching strategies for developing students' argumentation skills about socioscientific issues in high school genetics. *Research in Science Education, 40*(2), 133–148. https://doi.org/10.1007/s11165-008-9104-y

[8] Downe-Wamboldt, B. (1992). Content analysis: method, applications, and issues. Health Care for Women International, 13(3), 313–321.

[9] Eerde, D. Van, & Van Galen, F. H. J. (2019). Mathematical investigations for primary schools TAL bovenbouw View project impome View project. April. http://www.fisme.science.uu.nl/en/impome/

[10] García, F. J., Gascón, J., Higueras, L. R., & Bosch, M. (2006). Mathematical modelling as a tool for the connection of school mathematics. *ZDM - International Journal on Mathematics Education, 38*(3), 226–246. https://doi.org/10.1007/BF02652807

[11] Graham, M., & Lesseig, K. (2018). Back-pocket strategies for argumentation. *The Mathematics Teacher, 112*(3), 172–178.

[12] Hidayat, W., Wahyudin, & Prabawanto, S. (2018a). Improving students' creative mathematical reasoning ability students through adversity quotient and argument driven inquiry learning. *Journal of Physics: Conference Series, 948*(1). https://doi.org/10.1088/1742-6596/948/1/012005

[13] Hidayat, W., Wahyudin, & Prabawanto, S. (2018b). The mathematical argumentation ability and adversity quotient (AQ) of pre-service mathematics teacher. *Journal on Mathematics Education, 9*(2), 239–248. https://doi.org/10.22342/jme.9.2.5385.239-248

[14] Hsi, S., Linn, M. C., & Bell, J. E. (1997). Role of spatial reasoning in engineering and the design of spatial instruction. *Journal of Engineering Education*, *86*(2), 151–158. https://doi.org/10.1002/j.2168-9830.1997.tb00278.x

[15] Kondracki, N. L., Wellman, N. S., & Amundson, D. R. (2002). Content analysis: Review of methods and their applications in nutrition education. *Journal of Nutrition Education and Behavior, 34*(4), 224–230.

[16] Kozlowski, J. S., Chamberlin, S. A., & Mann, E. (2019). Factors that influence mathematical creativity. *The Mathematics Enthusiast, 16*(1), 505-540.

[17] Laycock, M. (1970). Creative mathematics at Nueva. *The Arithmetic Teacher, 17*(4), 325–328. https://doi.org/10.5951/AT.17.4.0325.

[18] Lin, P.-J. (2018). The Development of Students' Mathematical Argumentation in a Primary Classroom TT - O Desenvolvimento da Argumentação Matemática por Estudantes de uma Turma do Ensino Fundamental. *Educação & Realidade*, *43*(3), 1171–1192. http://www.scielo.br/scielo.php?script=sci_arttext&pid=S2175-62362018000301171&lang=pt

[19] Lindkvist, K. (1981). Approaches to textual analysis. *Advances in Content Analysis, 9*(1), 23–42.

[20] McTavish, D. G., & Pirro, E. B. (1990). Contextual content analysis. *Quality and Quantity, 24*(3), 245–265. https://doi.org/10.1007/BF00139259

[21] Mercier, H., & Sperber, D. (2013). Why do humans reason? Arguments for an argumentative theory. *Behavioral and Brain Sciences, 34*(2), 57–74.

[22] Nadjafikhah, M., Yaftian, N., & Bakhshalizadeh, S. (2012). Mathematical creativity: Some definitions and characteristics. *Procedia - Social and Behavioral Sciences, 31*(2011), 285–291. https://doi.org/10.1016/j.sbspro.2011.12.056

[23] Nasrullah, & Baharman. (2018). Exploring Practical Responses of M3LC for Learning Literacy. *Journal of Physics: Conference Series, 954*(1). https://doi.org/10.1088/1742-6596/954/1/012007

[24] OECD. (2010). Learning Mathematics for Life: A View Perspective From PISA. https://doi.org/10.1787/9789264075009-en

[25] OECD. (2016). PISA 2015 Assessment and Analytical Framework. In Science, Reading, Mathematics and Financial Literacy. http://www.oecd-ilibrary.org/education/pisa-2015-assessment-and-analytical-framework_9789264255425-en%0Apapers3://publication/doi/10.1787/9789264255425-en

[26] Sembiring, R. K., Hadi, S., & Dolk, M. (2008). Reforming mathematics learning in Indonesian classrooms through RME. *ZDM*, *40*(6), 927–939. https://doi.org/10.1007/s11858-008-0125-9

[27] Soekisno, R. B. A. (2015). Pembelajaran Berbasis Masalah Untuk Meningkatkan Kemampuan Argumentasi Matematis Mahasiswa. *Infinity Journal*, *4*(2), 120. https://doi.org/10.22460/infinity.v4i2.77

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

[29] Taskin, N., & Tugrul, B. (2014). Investigating Preschool Teacher Candidates' Mathematics Literacy Self-sufficiency Beliefs on Various Variables. *Procedia - Social and Behavioral Sciences, 116*, 3067–3071. https://doi.org/10.1016/j.sbspro.2014.01.708

[30] Tesch, R. (1990). Qualitative research—Analysis types and software protocols. Hampshire, UK: The Falmer Press.

[31] Vinner, S. (1997). The Pseudo-Conceptual and the Pseudo-Analytical Thought Processes in Mathematics Learning. *Entomologia Experimentalis et Applicata*, *34*(3), 239–248. https://doi.org/10.1023/A

[32] Walter, J. G., & Barros, T. (2011). Students build mathematical theory: Semantic warrants in argumentation. *Educational Studies in Mathematics*, *78*(3), 323–342. https://doi.org/10.1007/s10649-011-9326-1

[33] Weber, R. P. (1990). *Basic content analysis* (Issue 49). Sage.

[34] Yackel, E., & Hanna, G. (2003). Reasoning and proof. *A Research Companion to Principles and Standards for School Mathematics*, 227–236.