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CONTENT ANALYSIS OF STUDENTS' ARGUMENTS BASED ON MATHEMATICAL LITERACY AND CREATION ABILITY

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Abstract:
This study aims to show the content of students' argumentation in building their creative reasoning and the relationship between argumentation content and students' mathematical literacy skills. The type of research applied is descriptive qualitative research involving 27 junior high school students in Toli-Toli City, Central Sulawesi. The research instrument used was a like-mathematical literacy test and an assessment rubric. The collected data were analyzed using qualitative content analysis which was used to analyze text data. The results of the research show that 1) The content of students' arguments in building their creative reasoning is supported by using simple statements, complex statements, completed by syntax or no syntax in building mathematical arguments, and 2) the ability of students to show their argumentation in the problem solving is the level of their capacity to interpret and to represent their knowledge and learning experience related with the problem. The breadth and depth of content of students' mathematical literacy give them the flexibility to argue. Students' mathematical literacy ability by simply giving simple statements has a different breadth and depth than those who are able to give complex statements. Likewise with the shrewdness of using syntax in constructing problem-solving plans.

Keywords: Mathematical Argumentation, Creation Ability, Mathematical Literacy Ability

ANALISIS ISI ARGUMEN SISWA BERDASARKAN LITERASI MATEMATIKA DAN KEMAMPUAN KREASI

Abstrak:
Penelitian ini bertujuan untuk menunjukkan isi argumentasi mahasiswa dalam membangun penalaran kreatifnya dan hubungan antara konten argumentasi dengan kemampuan literasi matematika mahasiswa. Jenis penelitian yang diterapkan adalah penelitian kualitatif deskriptif yang melibatkan 27 siswa SMP di Kota Toli-Toli, Sulawesi Tengah. Instrumen penelitian yang digunakan adalah tes literasi serupa-matematis dan rubrik penilaian. Data yang terkumpul dianalisis menggunakan analisis isi kualitatif yang digunakan untuk menganalisis data teks. Hasil penelitian menunjukkan bahwa 1) Isi argumen mahasiswa dalam membangun penalaran kreatifnya didukung dengan menggunakan pernyataan sederhana, pernyataan yang kompleks, dilengkapi dengan sintaksis atau tanpa sintaksis dalam membangun

argumen matematika, dan 2) kemampuan peserta didik untuk menunjukkan argumentasinya dalam pemecahan masalah adalah tingkat kapasitas mereka untuk menafsirkan dan mewakili pengetahuan dan pengalaman belajar mereka yang terkait dengan masalah tersebut. Luas dan dalamnya isi literasi matematika siswa memberi mereka fleksibilitas untuk berdebat. Kemampuan literasi matematika siswa dengan hanya memberikan pernyataan sederhana memiliki keluasan dan kedalaman yang berbeda dengan mereka yang mampu memberikan pernyataan yang kompleks. Begitu juga dengan kelihaian menggunakan sintaksis dalam membangun rencana pemecahan masalah.

Kata Kunci: Argumentasi Matematika, Kemampuan Kreasi, Kemampuan Literasi Matematika

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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, Wahyudin, & Prabawanto, 2018) and knowledge of argumentation is 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, 2003).

Basically, students' ability to argue mathematically is supported by a creative motivation to explain logically and mathematically to solve a given problem (Walter & Barros, 2011). Creativity ensures the growth of mathematics as a whole. For the review of creativity, the opinion (Laycock, 1970) on mathematical creativity is the ability to analyze a given problem from different perspectives, see patterns, differences and similarities, generate many ideas, and choose appropriate methods to deal with unfamiliar mathematical situations (Idris & Nor, 2010).

Mathematical creativity is simply described as affirmation, or choice (Poincare, 1948 in (Nadjafikhah, Yaftian, & Bakhshalizadeh, 2012)). According to Poincare (Nadjafikhah, Yaftian, & Bakhshalizadeh, 2012), creating consists of not making useless combinations and making useful combinations and only a small part. Poincare refers to the fact that the "right" combination of only a small number of ideas produces creative insights whereas most such combinations do not produce creative results. Creative reasoning in this review is the line of thought adopted to produce statements and reach conclusions in solving problems. The reasoning is not necessarily based on formal logic and is therefore not limited to evidence; it may even be wrong as long as there are some plausible reasons (to a reasonable person) to back it up. This example illustrates that "reasoning" is used in a broad sense in this framework to denote high and low-quality arguments; the quality of the argument is characterized separately. Reasoning can be seen as a thought process, as a product of this process, or both. The data for investigations discussed here are behavioral; thus, we can only speculate about the underlying thought processes (Vinner, 1997).

Actually, what students want is to build that reasoning with their mathematical literacy knowledge. Mathematical literacy is part of the competencies that must be possessed by students (Nasrullah & Baharman, 2018; OECD, 2010). As an ability, mathematical literacy must be used by students, especially to solve the problems at hand, but its use still needs improvement. To a survey report by OECD (2010), mathematical literacy includes processes of problem-solving, assessment, communication, also critical and creative thinking, and is believed to be at least as important as literacy by contemporary society (Taskin & Tugrul, 2014). Using mathematical literacy is not easy because it requires knowledge and sensitivity to connect that knowledge with problem phenomena found in everyday life, although phenomena of everyday life can be used to attract students to study mathematics (Sembiring, Hadi, & Dolk, 2008). The given problem becomes a stimulant for students to develop mathematical literacy skills (Eerde & Galen, 2019). However, building mathematical modeling comes from contexts or situations found in everyday life. This is also a concern in the world of mathematics education with the development of mathematical literacy skills. To develop mathematical literacy skills, it is necessary to connect students' knowledge with various contexts of students' lives, both personal and community, where people work, and those related to science.

As a result of observations of learning activities in schools, students still lack learning actions that provide opportunities for them to develop mathematical literacy skills. The opportunity referred to in this case is a learning opportunity where building requires an allocation of learning time (Carroll, 1963; Cogan & Schmidt, 2014). The study of practical mathematics and learning opportunities is related to the process by which individuals know the content of mathematics (Barnard-Brak, Lan, & Yang, 2018). This new definition of learning opportunities includes factors that significantly influence teacher teaching practices and student learning. The factors in question involve content coverage and emphasis. For this reason, in building mathematical arguments students not only need to get creative encouragement but the content that builds the content of the argument needs to be emphasized. Not infrequently the learning outcomes achieved do not produce better learning outcomes. Indeed, mathematical literacy skills require structured reinforcement from the teacher through learning activities that contain exercises to use these abilities. In this study, this article will show both of the following questions: (1) What is the content of students' arguments in building their creative reasoning? (2) Is there a relationship between the content of the argument and the mathematical literacy ability of students?

METHODS

To support this research, the type of research applied is descriptive qualitative. In the application of the research method, the research subjects involved were 27 junior high school students in Toli-Toli City, Central Sulawesi which is chosen for subject extension in the location of the Sulawesi zone. They are given a single question of a mathematical literacy test that is designed in such a way that students can describe answers that are also equipped with reasons related to these answers. To complete the mathematical literacy test instrument, a rubric was prepared as a guide in providing an assessment. This rubric contains only some indicators of mathematical abilities based on OECD (2010), namely, Representation, Interpretation, and Argumentation (RIA). In relation to the creative ability, the contain of RIA is seen in terms of simple statement keywords, complex keyword statements, and statement keywords with syntax. The keywords for simple statements intended in this study are keywords or the basic ideas that underlie the reasoning arguments built in the answers. If the keyword contains more than important ideas in the construction of the argument, it is called a complex statement keyword. The structure of argumentation also is observed in the way students use the syntax in the form of known, asked, and answered patterns so that if students' reasoning arguments contain such things, they are equipped with basic ideas in the reasoning, the term used to identify them is Keyword Statements with Syntax.

To support the content exploration of 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, Thorp, & Donohew, 1967; Lindkvist, 1981; McTavish & Pirro, 1990; Tesch, 1990). Text data may be in verbal, printed, or electronic form and may be obtained from open-ended questions, interviews, or observations (Kondracki, Wellman, & Amundson, 2002). The 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-Wamboldt, 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.

In this content analysis, this study reviews the argumentation keywords that appear in the descriptions built by students.

Table 1. The Rubric of Content Analysis for Students' Argumentation

No.	Category	Description
1.	Simple statement keywords	Keywords or the basic ideas simply that underlie the reasoning arguments built in the answers
2.	complex keyword statements	the keyword contains more than important ideas in the construction of the argument
3.	statement keywords with syntax	Using syntax in the form of known, asked, and answered patterns so that if students' reasoning arguments contain such things, they are equipped with basic ideas in the reasoning

RESULTS AND DISCUSSION

In this discussion, it is divided into several parts consisting of 1) questions, 2) examples of student answers, and 3) a collection of core argumentation statements, the descriptions are presented as follows.

1. Problem

The picture below shows the sample of the representational house which is usually used for meetings of regional officials, in addition to the house a garage for official vehicles will be built, which has one door and one window.

Figure 1. The Sample of Traditional House and the alternative choice of the figure after doing the rotation

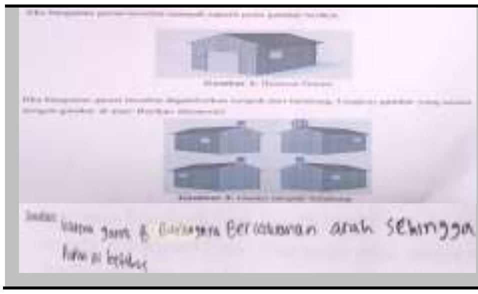
Based on the figures above, then the garage building is depicted as seen from the back. Circle the right picture that matches the left picture above! Give your reasons!

2. Sample of Students' Answers

a. 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.

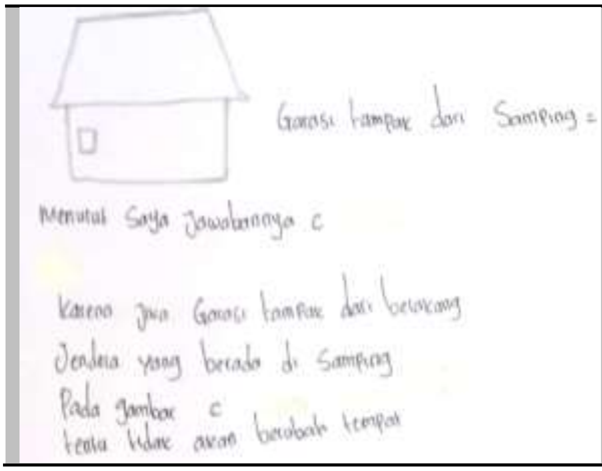
Table 2. Example of Student's Answers with incorrect Simple Statements

Student's Answers	Description
	In this student's answer, the argument used is that the shadow from the garage is in the opposite direction so that the board is known. The essence of the statement is the opposite direction so that the position of the garage when viewed from behind will appear on the right. Therefore, the chosen answer is B.

b. 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.

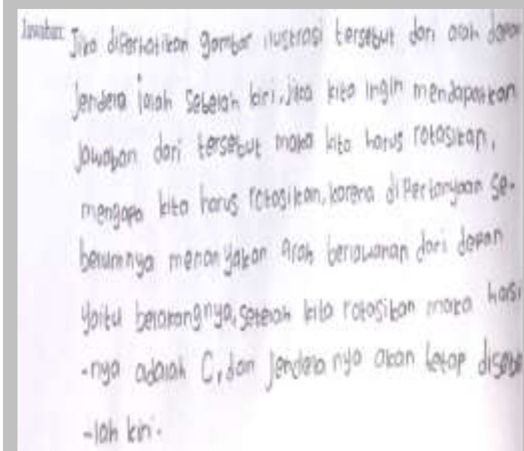
Table 3. Examples of Student's Answers with Correct Simple Statements

Student's Answers	Description
	In this student's answer, the argument built is that according to the student the answer is C. Because if the garage is seen from behind the window on the side in picture c, of course, it will not change its place. The essence of the argument made is the location of the window. To strengthen the argument, first described the position of the garage from the side.

c. Student's Answers with Correct Complex Statements

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

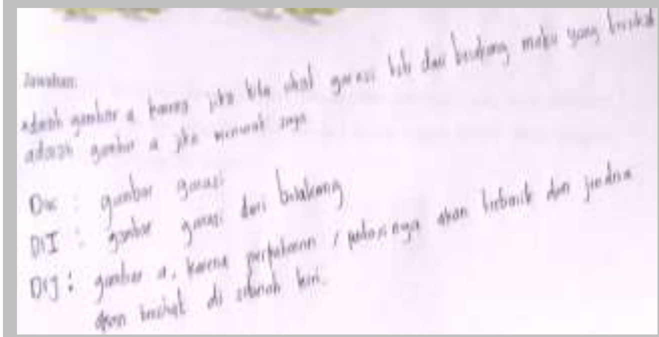
Table 4. Examples of Student's Answers with Correct Complex Statements

Student' Answers	Description
	Look at the students' arguments in this answer: "If you look at the illustration from the front of the window, it is on the left, if we want to get an answer from that, we have to rotate it. We have to rotate because the previous question asked about the opposite direction from the front, namely the back. After we rotate it, the result is C, and the window will stay on the left." In this answer, the concept used is not only the location of the window but also the concept of rotation of the window/object. The use of the concept of rotation corresponds to the question in the problem that asks for the opposite direction.

d. Student's Answers with Incorrect Syntax Statements

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

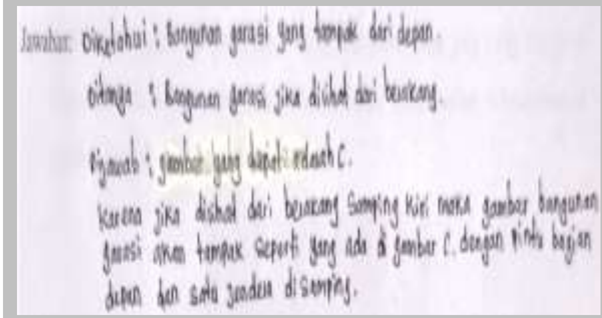
Table 5. Examples of Student's Answers with Incorrect Syntax Statements

Student' Answers	**Description**
 Text Content in The Figure "*Jawaban* *adalah gambar a karena jika kita lihat garasi tersebut dari belakang maka yang terlihat 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*"	In this student's answer, the argument that was built was "image a because if we look at the garage from behind, what we see in the image an if in my opinion" 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 intended syntax is the Known, Asked, and Answered stages as steps in preparing arguments. The argument that is built involves a complex concept that not only looks at the location of the window but also the concept of rotation/rotation of the object. However, the interpretation of the object's rotation does not provide reinforcement for the correct answer.

e. Student's Answers with Correct Syntax Statements

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

Table 6. Examples of Student Answers with Correct Syntax Statements

Student' Answers	Description
 Text Content in The Figure *"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 intended syntax is the Known, Asked, and Answered stages as steps in preparing arguments. The argument that is built involves a complex concept that not only looks at the location of the window but also the concept of rotation/rotation of the object. However, the interpretation of the object's rotation does not provide reinforcement for the correct answer.

3. A Collection of Core Arguments

Based on the data collection collected in this study, there were 4 groups of presentations that were found, namely, 1) the answer group with no argumentative statement, 2) the answer group with simple statement keywords, 3) the answer group with complex statement keywords, and 4) group answers with keyword statements arranged through syntax. Interestingly, 2 students did not give reasons in the construction of their answers. One of them has a right answer and a wrong answer. Although it is not clear what kind of argument is built so that one of the two students can give the correct answer choice, it is possible that the environment in which he gets the answer can support it.

a. Simple Statement

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

Table 7. Simple Statement Keywords

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 the back • Window shape and location • A, B, and 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, and 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

As seen in table 7 above, 13 variations of statements submitted by students were presented in constructing their respective answers. One of the forms of the statement, there is 1 statement that directs students which reads "The image is in the opposite direction" and the answer choices taken are not as expected or wrong in giving answers. The arguments that are built are not in line with the interpretation of the context of the picture which has an impact on the consequences of problem-solving. This is related to students' mathematical literacy skills where the use of reading skills and communicating the information obtained by reasoning is not strong enough to support these students to conclude.

In addition, for the variety of statements that support students on the correct answer, there are 12 statements that are built up in their arguments.

Behind the 12 statements, there are 2 forms of ideas built by students, namely 1) referring to the location/position of the window, and 2) testing the answer choices by paying attention to the location/position of the window.

b. Complex Statement

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

Table 8. Complex Statement Keywords

Statement	Respond
• 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 is seen from behind the side window	Correct Answer

As can be seen in table 8 above, the results of student work showed that there was nothing that did not meet the estimates, all of the answers were correct. The complexity of the answers shown by students can be seen from the concepts of orientation, rotation, and visualization that are applied, for example seeing from 2 or more sides (front view and back view; direction and rotation; view, rotation, and position; image representation and view). The ability of students to argue and reason so those appropriate decisions are made shows that they can take advantage of the information provided and the mathematical literacy of users is different from one another.

c. Statements with Syntax

Although it is not foreign when they use syntax in compiling the solution of a given mathematical problem, this seems to be the way they are commonly used in learning mathematics they follow. The syntax pattern used is known, asked, and answered. In solving the problem, they construct, the form of the statement is formulated as follows.

Table 9. Keyword Statements with Syntax

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

As seen in table 9 above, the results of searching student answers using the syntax found that one of them gave the wrong answer. Even if you review what he gave in the construction, the answer uses the concept of orientation (position) and rotation and is arranged in a hierarchical syntax. While other students' answers, the correct answer shows that the syntax, the way of presenting the answer is more hierarchical and neater. The concept that is only used is the concept of orientation (position from 2 sides) which is supported by good argumentation and reasoning.

Based on the explanation stated above, this study tends to explain some important information below.

1) The content of students' arguments in building their creative reasoning

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 the problem, it is their way of being creative to achieve the targeted goals (Poincare in (Nadjafikhah, Yaftian, & Bakhshalizadeh, 2012), such as taking 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 (W Hidayat, Wahyudin, & Prabawanto, 2018).

It seems that spatial reasoning (holistic, analytic, and pattern-based) (His, Linn, & Bell, 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 in 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 the students did not show the argumentation ability well.

However, it is seen from what has been shown by students in their work, that 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 (Garcia, Perez, Higueras, & Casabo, 2006).

2) Relationship between the content of the argument and the mathematical literacy ability of students

This study shows several skill-oriented transformations toward a problem-based reform approach (Sembiring, Hadi, & Dolk, 2008), in the form of mathematical literacy problems are intended to highlight the preparation for using mathematics in learning, high-level technical profession (Stacey, 2011). In the other words, the ability of students to present their argumentation content can be seen from the high level of mathematical literacy. At this level, the broader their mathematical concept, the more understanding they have, and the more make sense of their argumentation construction. Although age is considered to see how the written argument is structured (Karl W Kosko & Belinda S Zimmerman, 2019), students who take advantage of each learning opportunity that was followed previously will show how the student's ability to argue can develop well (Anderson, 2008; Cutler & Graham, 2008; Gilbert & Graham, 2010; Johnson, 2013; Kuihara, Graham, & Hawken, 2009; Martin & Martin, 1989; Scherff & Piazza, 2005). The use of learning opportunities is also not only limited to participating in learning activities well but how well students absorb the content of the material because it subsequently becomes meaningful learning the knowledge and experiences. It is this ability to absorb the knowledge that has an impact on the ability of students to argue simply but correctly, complexly and correctly, structured with syntax simply or complexly. After that absorption process, knowledge and learning experiences become part of the mathematical literacy abilities of students involved in supporting the interpretation and representation of the absorption of such knowledge. The breadth and depth of content of students' mathematical literacy give them the flexibility to argue. In other words, students' mathematical literacy ability by simply giving simple statements has a different breadth and depth than those who are able to give complex statements. Likewise with the shrewdness of using syntax in constructing problem-solving plans. Of course, the understanding of syntax has framed students' mathematical literacy skills so that they know their importance and usefulness.

CONCLUSION

Based on the results of the research presented above, some conclusions are obtained as follows: 1) the content of students' arguments in building their creative reasoning is supported by using simple statements, complex statements, completed by syntax or no syntax in building mathematical arguments, 2) the ability of students to show their argumentation in the problem solving is the level of their capacity to interpret and to represent their knowledge and learning experience related with the problem. The breadth and depth of content of students' mathematical literacy give them the flexibility to argue. In other words, students' mathematical literacy ability by simply giving simple statements has a different breadth and depth than those who are able to give complex statements. Likewise with the shrewdness of using syntax in constructing problem-solving plans.

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