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Learning Mathematical Modelling: Junior School Student's Argumentative Ability Through a Visual-Formed Problem

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ABSTRACT
This paper was to describe junior high school students' argumentative ability mathematically using a visual-formed problem. The type of this research was descriptive with a qualitative approach. The subjects of this research were 19 students of the 7th grade-student of SMPN 6 Inderalaya Utara. A post-test was used to collect data to describe the students' ability to give arguments mathematically. This research found that the percentage average of the students' argumentative ability was 41,66%. Besides, the students were interested in studying a visual-formed mathematical problem under a mathematical modelling framework.

Keywords: *Mathematical argumentative ability, visual-formed problem, mathematical modelling.*

1. INTRODUCTION

Mathematics can help students think logically, critically, and rationally [1]. According to the 2013 curriculum, students are required to be actively involved in learning mathematics. They are expected to have 4C characteristics, namely: *Communication, Collaboration, Critical Thinking, and Problem Solving, Creativity, and Innovation*. Of the 4C characteristics, there are communication skills and critical thinking skills related to and unitary with the argumentation skills [2]. Argumentation is one of the skills that students should have [3].

Argumentation is the process of gathering various components needed to build an opinion [4]. According to [5], argumentation becomes one of the special concerns for the students' success in daily life and mathematics. One of the skills students should learn, and master is mathematical argumentation skills, including proving and using strategies [6]. Mathematics learning should encourage students to express ideas, defend them argumentatively, and include accurate and precise reasons [7]. In mathematics learning, they do not only learn how to solve problems but also learn how to argue [8]. According to [9], the higher the level of one's argumentative skills, the better the skills to provide reasons for solving the problem. We can now say that argumentation skills are needed to explain logically and account for their strategies in solving a problem.

However, Students' argumentation skills are still low. In accordance with the observation by [10], students were not interested in responding to the learning that has been taught and responses to others' answers. Supported by the results of [7] observation that the research subjects were still not active during learning and did not dare to ask questions when they did not understand the material, so they chose to imitate their friends' answers when working on the questions. Besides, the 2018 PISA results showed that Indonesia was ranked 75th out of 80 countries with scores far below average [11]. Meanwhile, PISA was a result that required the argumentation [12]. The bottom-ranked results showed that Indonesian students' argumentation skills were still low.

Indonesian students were not accustomed to working on questions emphasizing the application of

mathematics in daily life bottom-ranked one of the factors why the ranking was low [13]. Mathematics taught in Indonesia focused more on numeracy and memorization skills [3]. According to [7], in shaping the students' argumentation skills, the teachers' role was needed. So far, the teachers had only provided formulas and let students use them without telling them the origin of the formulas, so they lost the material concept. This fact was certainly not in line with the 2013 curriculum goals and affected students' undeveloped mathematical argumentation skills. Therefore, there needs to be a change in the learning process that leads to an improvement in the students' mathematical argumentative skill. Teachers must be innovative in choosing the right instructional approach, such as the mathematical modeling approach. It is because mathematical modeling can construct a mathematical concept, problem-solving, reasoning, and argumentation skills.

Mathematical modeling is the process of changing real-world problems into mathematical forms to find solutions to problems [14]. The steps in the mathematical modeling are essential for developing the students' mathematical abilities since the students will be skilled at converting the real-world problems to mathematical models, which means that they will get used to understanding problems and linking concepts so that they are able to model and then solve the problems [15]. Accordingly, learning with a mathematical modeling approach can help them improve their argumentation skills.

The previous research that connected mathematical modeling with argumentation skills was conducted by [8]. Nonetheless, research that discussed the argumentation skills using visual questions was still very rare. Hence, apart from modeling, there was visual imagination, which also played an important role in understanding [16]. In mathematics learning, visualization became a powerful tool for exploring mathematics and giving meaning to the mathematical concepts and their relationships [17]. Visualization could also foster student interest and understand the material content and the real world [18]. It was in line with [19] research showing that. Consequently, the researchers would explore Junior High School students' argumentation skills by applying the visual-formed problem under a mathematical modelling framework. The researchers would describe the argumentation skills of students grade VII.1 of SMPN 6 Indralaya Utara through the visual-formed problem.

2. RESEARCH METHOD

This research was a descriptive research with a qualitative approach that aimed to describe or provide an overview of students' mathematical argumentation skills through mathematical modeling learning, which uses visual-formed problem. The subjects in this study were 19 students grade VII.1 of SMP 6 Indralaya Utara. This research was conducted in the even semester of the 2019/2020 school year.

The research focused on students' mathematical argumentation skills at SMP Negeri 6 Indralaya Utara through mathematical modeling learning, which uses visual-formed problem. The skill indicators used in this study are as follows:

Table 1. Argumentative Skill Indicators

Indicator	Descriptor
Claim	Statement or conclusions are made based on data
Data	Foundations or arguments based on facts relevant to the claim
Qualification	Answer statement correctly and accurately according to the mathematical theory
Warrant	The rationale is used to generate conclusions to investigate the truth of the statement given.

This research was conducted for three meetings. At the first meeting, a pre-test was carried out, aiming to determine the students' initial skills to the inverse proportion material and divide them into several discussion groups based on the obtained pre-test results. These discussion groups would be used when mathematical modeling learning.

The second meeting was mathematical modeling learning, which uses a visual-formed problem. The students sat with their respective groups, and each group would be given a visual question mathematical modeling to be solved with the group. The visual question was a mathematical modeling problem presented visually in the form of tables and pictures and equipped with Student Worksheet (LKPD), which contained questions that guided them to obtain solutions to the problems given by paying attention to the mathematical modeling stages, namely 1) identifying the problem; 2) making assumptions and defining the variables; 3) formulating the mathematical model; 4) solving the model/doing mathematically and applying the model; 5) repeating/reviewing. The discussion and question and answer sessions were carried out under the teacher's guidance. The following is the mathematical modeling problem in the form of a visual question.

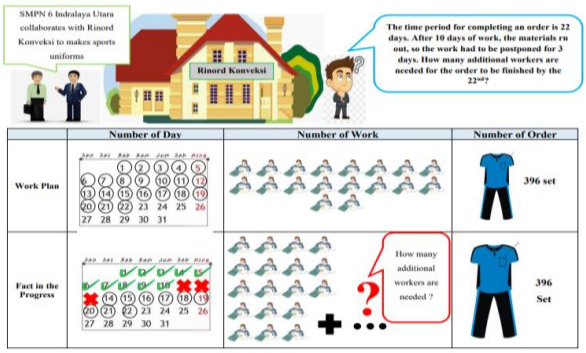

Figure 1. Mathematical modeling problem in the form of visual question

At the third meeting, a post-test and interviews were carried out. The post-test aimed to see the students' argumentative skills in solving the inverse proportion material's contextual problems. This post-test question consisted of one text question in the form of a description. The following are the students' argumentation skill indicators and post-test scoring guidelines used in this research.

Table 2. Post-test Scoring Guidelines

No	Indicator	Descriptor	Answer Criteria	Score
1	Claim	Statements or conclusions made based on data	No claim	0
			Claim but wrong	1
			Claim but incorrect	2
			Claim correctly	3
2	Data	Foundations or arguments based on facts relevant to the claim	No data	0
			Data but wrong	1
			Data but incorrect	2
			Data correctly	3
3	Qualification	Answer statements correctly and accurately according to the mathematical theory	No qualification	0
			Qualify but wrong	1
			Qualify but incorrect	2
			Qualify correctly	3
4	Warrant	The rationale used to generate conclusions to investigate the truth of the statements given	No answer	0
			Answer but wrong	1
			Answer but incorrect	2
			Answer correctly	3

The data collection techniques in this research were through tests and interviews. This research test was a post-test that consisted of one description question with the inverse proportion material. The interview activity in this research aimed to find out more deeply the students' mathematical argumentation skills and how students perceived problems related to daily life and visual problems are given. All data that had been collected were then analyzed. The work results would be corrected for the post-test results and scored according to the post-test scoring guidelines. The score obtained was then used to determine the final score obtained by the students. Meanwhile, the interview data in the form of recordings would be converted into the written form using good and easy-to-understand language. The following are the students' argumentation skill categories:

Table 3. Argumentation Skill Categories

Score Ranking	Skill Category
85 < score ≤ 100	Excelent
65 < score ≤ 85	Good
40 < score ≤ 65	Adequate
0 < score ≤ 40	Poor

3. RESULT AND DISCUSSION

3.1. Result

The following are the test results and the percentage of occurrence of the students' argumentation skill indicators in solving the post-test question.

Table 4. Students' Argumentation Skill Categories

Score	Category	Argumentation Skill	
		Frequency	%
86 – 100	Excelent	0	0%
66 – 85	Good	2	10.53%
41 – 65	Adequate	7	36.84%
0 - 40	Poor	10	52.63%
Total		19	
Average Score	41.66		100%

Table 5. Percentage of Occurrence of Argumentation Skill Indicators

Student's argumentation skill indicators	Persentase
Claim	63.16%
Data	26.32%
Qualification	38.60%
Warrant	43.86%

Based on the students' post-test results, the researchers interviewed several students to find out more deeply the argumentation skills of 7th-grade students of Junior High School in solving the problem through the mathematical modeling learning, which uses visual-formed problem, as well as seeing the students' views of the daily life questions in accordance with the mathematical modeling and visual question frameworks. Here are the answers from the two subjects.

3.1.1. Subjek of AW

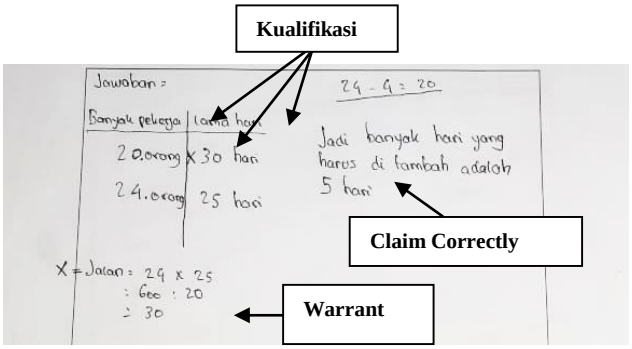

Figure 2. Results of AW's post-test answer.

From AW's post-test answer results, AW answered questions by not writing down the data correctly and precisely. It caused AW to get a score of 0 for the Data skill indicator. AW had been able to model the problem into the mathematical form correctly and accurately, so the Qualification skill indicator was given a maximum score of 3. For the Warrant indicator's appearance, AW was able to solve the problem correctly, but in the process, it was still incomplete even though the calculations were correct. It could be seen from the picture above. AW got a score of 2. In the Claim indicator, AW got a maximum score of 3 since AW was able to claim the answer appropriately and correctly.

The following is the interview the researchers conducted with AW to see AW's mathematical modeling learning views, which uses visual-formed problem.

R : "According to AW, can mathematics lessons be used in daily life?"
AW : "Yes, it can be used."
R : "Why?"
AW : "Because it has something to do with life."
R : "Can you give me the example?"
AW : "Trade, just like yesterday example, making orders for clothes."
R : "Do you have to memorize the formula when working on yesterday's question?"
AW : "Yes, I have to memorize the formula."
R : "How about the visual-formed problem you studied yesterday?"
AW : "I do not have to memorize the formula."
R : "Which one is easier to use? The visual or regular mathematical modeling?"
AW : "It is easier to use the formula or the regular one."
R : "If you forget the formula, which method is easier to use?"
AW : "It is easier not to memorize formulas but to use tables."
R : "What operations are used?"
AW : "Addition, subtraction, multiplication, and division."
R : "Is AW interested or not in using the visual learning method?"
AW : "I am interested in it."
R : "Is the visual learning method boring?"
AW : "It is not boring since I can work with my friends."
R : "Is the visual learning method easier to understand?"
AW : "Yes, it is easier."

Based on the researchers' interview results with AW, AW revealed that mathematics learning could be used daily. Moreover, the visual learning method was not boring since AW could work together with other students. From this collaboration, argumentation skills could be generated, starting from the interactions used as data to support the students' claims. AW also stated that the visual-formed problem was easier to understand.

3.1.2. Subjek of LL

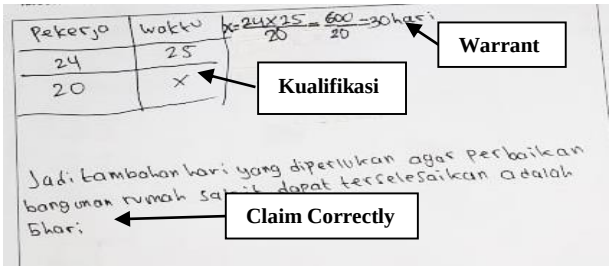

Figure 3. Results of LL's post-test answer

From LL's post-test answer results, LL did not write down the data, so AW got a score of 0 for the occurrence of the Data indicator. LL had correctly modeled the problem into the mathematical model, so LL got a 3 for the Qualification indicator. Furthermore, for the Warrant indicator, LL was able to solve the problems using the existing formula appropriately. It can be seen in Figure 12 that LL's answer was good, so LL got a maximum score of 3 on the occurrence of the Warrant indicator. In LL's answer, LL was able to claim the correct answer. LL was already able to claim the claims with correct arguments, so LL got a maximum 3 for the Claim indicator.

The following is the interview the researchers conducted with LL to see LL's views of the mathematical modeling learning, which uses visual-formed problem.

R : "Is the mathematics taught directly related to events in daily life?"
LL : "Yes."
R : "Can LL use the mathematics taught in daily life?"
LL : "Yes, LL can use it in daily life."
R : "Does the mathematics taught require LL memorize formulas?"
LL : "No. I only use simple operations, such as subtraction, addition, division, and multiplication."
R : "Does the mathematics taught make LL happy to learn in the class?"

LL : "With this learning, LL feels happier since I can work together in groups."
R : "Is the mathematics taught more interesting than the mathematics lessons in the books?"
LL : "According to LL, it is more interesting."
R : "Does LL want all mathematics lessons are taught like just now?"
LL : "Yes, I do."
R : "Does the mathematics taught make LL not boring to learn mathematics in the class?"
LL : "LL is not bored since it contains many pictures."
R : "Should the duration of the mathematics lessons be increased if the mathematics lessons are taught like just now?
LL : "According to LL, it is okay."
R : "Do the pictures on the mathematics lessons taught help LL understand what to do and look for?"
LL : "Yes. The posters really help LL in understanding and solving the problems given."

Based on the researchers' interview results with LL, LL revealed that the visual-formed problem could make it easier to understand the problems and solve them. LL also expressed LL's desire to learn mathematics to use the visual-formed problem. The visual-formed problem made learning fun for LL. Additionally, there were also pictures that made students not bored with learning mathematics. Besides, LL felt it was helpful to work together with friends. From this collaboration, it could help LL argue since the more interactions existed, the more it could help students' argumentation better. This interaction could learn data that could support the claims, so the students' answer claims were correct.

3.2. Discussion

Some pictures made at discussed the argumentation skills of SMP Negeri 6 Indralaya Utara beneficial own based on the post-test result Thisdents who had carried out the mathematical modeling learning which uses a visual-formed problem. The mathematical argumentation skill indicators, including Claim, Data, Qualification, and Warrant, could be developed [20].

Based on the percentage of occurrence of each indicator of the argumentation skills, it could be seen that the highest percentage of occurrence was the Claim indicator by 63.16%. Furthermore, the Warrant indicator was 43.86%. The occurrence of the Qualification indicator was 38.60%. The occurrence of the indicator of low argumentation skills was the Data indicator by 26.32%. In the Data indicator, there were still many students who did not write down the data correctly. There were still many students who did not write down what data were on the questions. Meanwhile, in the occurrence of the Qualification indicator, there were still many students who had not been able to model the mathematics well. There were still many students not precise in doing it mathematically or solving the problems in the Warrant indicator.

Based on the test results, the students' argumentation skills consisted of four categories, namely Excellent, Good, Adequate, and Poor. Nevertheless, in this research, the students' post-test results only fulfilled three categories, namely Good, Adequate, and Poor. There were still no students who met the Excellent argumentation skill category. The average argumentative skills of students grade VII.1 of SMPN 6 Indralaya Utara were still in the Adequate category. The application of mathematical modeling learning was only carried out during one meeting, so it had not been able to make all students get maximum results. With the frequent application of mathematical modeling learning, it was hoped to train the students' argumentation skills. Another factor that also affected it was the student interest in learning mathematics. Those who had a good argumentation skill category were interested in learning mathematics and were indeed active students in the class during the learning process. Meanwhile, those who had fewer argumentation skills were those less interested in learning mathematics since they thought that mathematics was a difficult subject.

4. CONCLUSIONS

The findings indicated that students grade VII.1 of Junior High School Number 6 Indralaya Utara's argumentation skills were still in the adequate category on average. This is because modeling learning using visual questions is only carried out in one meeting. Based on the tests conducted, the visual question could improve the students' mathematical argumentation skills. Visual problems assist students in bringing up students' argumentative abilities.

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REFERENCES

[1] Yusdiana, B. I., & Hidayat, W. (2018). Analisis Kemampuan Penalaran Matematis Siswa SMA Pada Materi Limit Fungsi. JPMI (Jurnal Pembelajaran Matematika Inovatif), 1(3), 409. https://doi.org/10.22460/jpmi.v1i3.p409-414

[2] Devi, N. D. C., Susanti, E., & Indriyanti, N. Y. (2018). Analisis Kemampuan Argumentasi Siswa SMA pada Materi Larutan Penyangga. JKPK (Jurnal Kimia Dan Pendidikan Kimia), 3(3).

[3] Fauziah, V. D. (2016). Keefektifan Model Pembelajaran Discovery Learning Berbantuan Question Box dan Model Two Stay Two Stray (TST) Terhadap Kemampuan Komunikasi Matematis Siswa SMK. UNS Journal, 1(2).

[4] Simon, S., Erduran, S., & Osborne, J. (2006). Learning to Teach Argumentation: Research and development in the science classroom. International Journal of Science Education, 28(2–3), 235–260.

[5] Kuhn, D., & Moore, W. (2015). Argumentation as core curriculum. Learning: Research and Practice, 1(1), 66–78.

[6] Hartatiana. (2019). Pengembangan Soal pemecahan masalah berbasi argumen untuk siswa kelas V SD Negeri 79 Palembang. Journal of Chemical Information and Modeling, 53(9), 1689–1699.

[7] Nisa, K. (2017). Profil kemampuan argumentasi siswa dalam menyelesaikan masalah matematika ditinjau dari aktualisasi diri siswa.

[8] Wulandari, W., Darmawijoyo, & Hartono, Y. (2016). PENGARUH PENDEKATAN PEMODELAN MATEMATIKA TERHADAP KEMAMPUAN ARGUMENTASI SISWA KELAS VIII SMP NEGERI 15 PALEMBANG. JURNAL PENDIDIKAN MATEMATIKA, 1.

[9] Soekisno, R. B. A. (2015). Pembelajaran berbasis masalah untuk meningkatkan kemampuan argumentasi matematis mahasiswa. 4(2), 120–139.

[10] Pugalee, D. K. (2001). Writing, Mathematics, and Metacognition: Looking for Connections Through Students' Work in Mathematical Problem Solving. School Science and Mathematics, 101(5), 236–245. https://doi.org/10.1111/j.1949-8594.2001.tb18026.x

[11] OECD. (2018). Pisa for development science framework. In OECD, PISA for Development Assessment and Analytical Framework: Reading, Mathematics and Science. Paris: OECD Publishing.

[12] Sari, F. E. P. (2015). Pengembangan Soal Matematika Model PISA Untuk Mengetahui Argumentasi Siswa di Sekolah Menengah Pertama. 124–147.

[13] Azizah, R. F., Sunardi, & Kurniati, D. (2017). penalaran Matematis dalam menyelesaikan PISA pada siswa usia 15 tahun di SM Negeri 1 Jember. 8(1), 97–104.

[14] Ang, K. C. (2010). Teaching and learning mathematical modelling with technology.

[15] Astuti, M., Siswati, & Setyawan, I. (2018). Hubungan antara persepsi terhdapa pembelajaran kontekstual dengan minat belajar matematika pada siswa kelas VII SMP Negeri 18 Semarang.

[16] Paradesa, R. (2016). PENGEMBANGAN BAHAN AJAR GEOMETRI TRANSFORMASI BERBASIS VISUAL. Jurnal Pendidikan Matematika JPM RAFA, 2(1), 56–84.

[17] Rösken, B., & Rolka, K. (2006). A picture is worth a 1000 words – The role of visualization in mathematics learning. Proceding 30th Conference of the International Group for the Psychology of Mathematics Education, 457–464.

[18] Nugrahani, R. (2007). Media Pembelajaran Berbasis Visual Berbentuk Permainan Ular Tangga Untuk Meningkatkan Kualitas Belajar Mengajar Di Sekolah Dasar. Lembaran Ilmu Kependidikan, 36(1), 35–44.

[19] Hoogland, K., Pepin, B., Koning, J. de, Bakker, A., & Gravemeijer, K. (2018). Word problems versus image-rich problems: an analysis of effects of task characteristics on students' performance on contextual mathematics problems. Research in Mathematics Education, 20(1), 37–52.

[20] COMAP & SIAM. (2019). GAIMME : Guidelines for Assessment & Instruction in Mathematical Modeling Education (Second Edition).