Mathematical communication skills of junior high school students based on statistics

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DOI: https://doi.org/10.31980/pme.v2i3.1770

Submission Track:
Received: 15-09-2023 | Final Revision: 15-10-2023 | Available Online: 30-10-2023

How to Cite:
Sulastri, E. (2023). Mathematical communication skills of junior high school students based on statistics. *Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu (PME)*, 2(3), 373-384.

Abstract
This study is a descriptive qualitative study that aims to reveal students' mathematical communication skills in solving Statistics problems. The subjects of the study were junior high school students in grade VIII with a population of 128 students and the sample of this study was 2 people who were determined by purposive sampling. From the results of the study, it was concluded that the level of students' mathematical communication skills in solving Statistics problems can be concluded as follows: students do not master statistical concepts or materials, students are less careful and thorough in solving mathematical communication skills problems, students' ability to draw conclusions is still relatively low, and students answer questions without providing clear reasons. Thus, referring to the results of the analysis of the sample of grade VIII in one of the junior high schools where the researcher lives, it shows that the level of students' mathematical communication skills is in the category of less or still low.
Keywords: Communication Skills; Mathematical Communication; Statistical Material

Abstrak
Penelitian ini adalah penelitian kualitatif deskriptif yang bertujuan untuk mengungkapkan kemampuan komunikasi matematis siswa dalam menyelesaikan soal Statistika. Subjek penenlitian adalah siswa SMP kelas VIII dengan jumlah populasi 128 siswa dan sampel penenlitian ini berjumlah 2 orang yang ditentukan secara *purposive sampling*. Dari hasil penelitian disimpulkan bahwa tingkat kemampuan komunikasi matematis siswa dalam menyelesaikan soal Statistika dapat simpulkan sebagai berikut: siswa kurang menguasai konsep atau materi statistika, siswa kurang cermat dan teliti dalam menyelesaikan soal kemampuan komunikasi matematis, kemampuan siswa dalam menarik kesimpulan masih tergolong rendah, dan siswa menjawab soal tidak disertai dengan alasan yang jelas. Dengan demikian, merujuk pada hasil analisis dari sampel kelas VIII di salah satu SMP di tempat peneliti tinggal menunjukkan bahwa tingkat kemampuan komunikasi matematis siswa dalam kategori kurang atau masih rendah.
Kata Kunci: Kemampuan Komunikasi; Komunikasi Matematis; Materi Statistika

Introduction

The rapid development of science and technology brings changes to various aspects of human life (Hapsoh & Sofyan, 2022). These changes bring about an era of tight global competition. With the existence of quality human resources, a person will be able to compete in the era of globalization (Robiah & Nuraeni, 2023).

One of the efforts to develop quality human resources is through education (Yanti & Novitasari, 2021; Hidayatuloh & Sumartini, 2022). Education is very important for every human being to develop their potential and for the progress of their nation and country. According to Law No. 20, 2003, National education aims to develop abilities and shape dignified character and civilization in order to educate the life of the nation and develop the potential of students to become people who believe and fear God Almighty, have noble character, are healthy, knowledgeable, capable, creative, independent and become democratic and responsible citizens. Based on this statement, it explains that education plays a role in developing human knowledge or behavior, so that a person must get an education to improve The increasingly rapid development of science and technology brings changes to various aspects of human life. These changes bring about an era of tight global competition. With the existence of quality human resources, a person will be able to compete in the era of globalization (Marliani & Puspitasari, 2022).

In order to achieve national education goals, learning is needed (Sulastri & Sofyan, 2022). Learning includes several things, one of which is mathematics. The characteristics of mathematics, namely having increasingly abstract objects according to the level of education, make students have difficulty in learning it (Hakiki & Sundayana, 2022). This is because mathematics is not just a matter of calculating but how to choose, utilize information quickly, accurately, and efficiently in solving problems, and how to formulate and interpret solutions that are made so that they are understood by oneself and others.

According to Kuzle (Rahim, 2018; Mutiarani & Sofyan, 2022) entering the 21st century, the development of the world of mathematics work in various fields, such as business, industry, natural and social sciences, requires students to learn mathematics more than just the mathematics program taught in schools. In other words, mathematics education in the 21st century requires quality human resources, have comparative, innovative, competitive and collaborative abilities so that they have the ability to adapt to the increasingly rapid changes of the times.

In mathematics learning, there are several mathematical skills that students must have (Ismayanti & Sofyan, 2021). One of them is mathematical communication skills which are one of the skills required in the curriculum in Indonesia. Communication is the process of conveying information between two or more, either directly (verbally) or indirectly (through media) which will result in feedback (reciprocity). Likewise in the context of

education, communication is an inseparable part. This is because in education there is a process of transferring information in the form of knowledge and experience between teachers and students, as well as between students and teaching materials. Good communication between teachers and students, between students and students, and between students and teaching materials will improve students' understanding of the material being taught.

NCTM (2000) emphasizes that student communication in mathematical language is very important, so it must be given from an early age. Mathematical communication skills are the ability to understand and express mathematical facts, thoughts and ideas that are owned so that others can understand them. In addition to being understood by others, communication is also useful for evaluating the truth of thinking. Through communication, students' mathematical thinking can be assessed for its correctness by both fellow students and teachers. Thus, students are given the opportunity to realize their mathematical thinking errors and try to correct them. This is in line with the opinion of Fauziah et al., (2018), Communication skills are important in learning mathematics because through communication students can find concepts, express and construct their ideas or ideas coherently.

Mathematical communication standards emphasize the importance of being able to speak, write, and explain mathematical concepts. Therefore, mathematical communication skills are very important in learning mathematics. The problem is found in the low mathematical communication skills of students. The mathematical communication skills of students in Indonesia are still relatively low, as shown in the results of research conducted by the Program for International Assessment (PISA). According to Pratiwi (2009) which was adapted from the results of the PISA report (OECD, 2018) Indonesia has participated in PISA in 2000, 2003, 2009, 2012, 2015, and 2018, the results did not change much in each participation.

Table 1. Indonesia's PISA Index Achievements for 200-2018.

Year	Materials to be Tested	Indonesia Average Score	Internasional Average Score	Indonesia Ranking	Number of Participating Countries
2000	Reading	371	500	39	41
	Mathematics	367	500	39	
	Science	393	500	38	
2003	Reading	382	500	39	40
	Mathematics	360	500	38	
	Science	395	500	38	
2006	Reading	393	500	48	56
	Mathematics	396	500	50	
	Science	393	500	50	
2009	Reading	402	500	57	65
	Mathematics	371	500	61	
	Science	383	500	60	

Year	Materials to be Tested	Indonesia Average Score	Internasional Average Score	Indonesia Ranking	Number of Participating Countries
2012	Reading	396	500	62	65
	Mathematics	375	500	64	
	Science	382	500	64	
2015	Reading	397	500	61	69
	Mathematics	386	500	63	
	Science	403	500	62	
2018	Reading	371	500	72	78
	Mathematics	379	500	74	
	Science	396	500	71	

From Table 1, it can be seen that the mathematics ability in 2000, it is clear that Indonesia got a score of 367 while the average international score was 500 and ranked 39th out of 41 countries. In 2003, it can be seen that Indonesia got a score of 360 while the average international score was 500 and ranked 38th out of 40 countries. In 2006, it can be seen that Indonesia got a score of 396 while the average international score was 500 and ranked 50th out of 56 countries. In 2009, it can be seen that Indonesia got a score of 371 while the average international score was 500 and ranked 61st out of 65 countries. In 2012, it can be seen that Indonesia scored 375 while the average international score was 500 and was ranked 63rd out of 69 participating countries with a score of 386 and an average international score of 500 while in 2018 Indonesia was ranked 74th out of 78 participating countries with a score of 379 and an average international score of 500. It is very clear that the mathematical communication skills of Indonesian students are still relatively low.

In relation to the results of previous research, the researcher conducted an interview with one of the junior high school mathematics teachers. Based on the results of the interview, general information was obtained that the mathematical communication skills of grade VII students were still relatively low. The following are the results of the interview: (1) Most students did not mathematically model existing contextual problems, (2) Most students did not explain the concepts and strategies they used in working on the questions given, (3) Most students did not interpret the solutions to the mathematical problems they obtained back into contextual problems.

One of the materials included in the Junior High School Mathematics curriculum is statistics. Researchers consider this material very important because statistical material is essential material. Statistical material explains about understanding the basic concepts of data presentation techniques in the form of tables and diagrams or graphs, interpreting the meaning of the diagrams or graphs presented, determining the mean, mode, and median of single data. The indicators of mathematical communication skills proposed by Hendriana, Rochaeti & Sumarmo (Syafina & Pujiastuti, 2020) include: a. Expressing real objects, situations, and everyday events into mathematical models (pictures, tables,

diagrams, graphs, algebra); b. Explaining mathematical ideas and models (pictures, tables, diagrams, graphs, algebra) into ordinary language; c. Explaining and making questions about the mathematics being studied; d. Listening, writing, and then discussing mathematics; e. Reading with understanding a written achievement; f. Making conjectures, constructing arguments, formulating definitions, and generalizations; and g. Explaining and making questions about the mathematics being studied.

Method

The approach used in this study is a qualitative approach with a descriptive research type. Research using this method aims to obtain in-depth and meaningful data. The intention is to describe the phenomenon, where researchers reveal students' mathematical communication skills based on statistical material. This study was conducted on junior high school students in grade VIII with a population of 128 students while the sample was 2 students who were determined by purposive sampling.

The data collection method used in this study was by providing a written test in the form of a description of the main topics of statistics. This research was conducted in December 2020 which was located in the researcher's domicile area. The test was carried out once in the form of a written test. The test was given to 2 students without exception. After the written test was completed, an interview was conducted which aimed to determine the students' thinking process in solving mathematics problems focused on statistical material. This interview was conducted based on the results of the summary of the written test of students' mathematical communication skills along with the results of the researcher's observations.

Result

This research was conducted on students of grade VIII of junior high school where the researcher lives. The following is an analysis of interviews and students' answers to each question.

The first question item with an indicator connecting real objects, pictures, and diagrams into mathematical ideas is as follows.

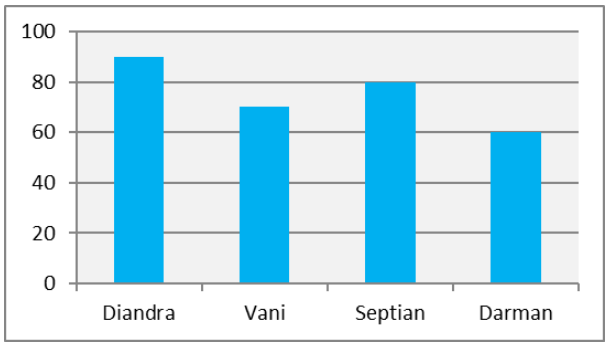

Figure 1. Analysis of question number 1 and interview

If you were asked to complete the title of the diagram, then how could you connect the mathematical concept that matches the title you created!

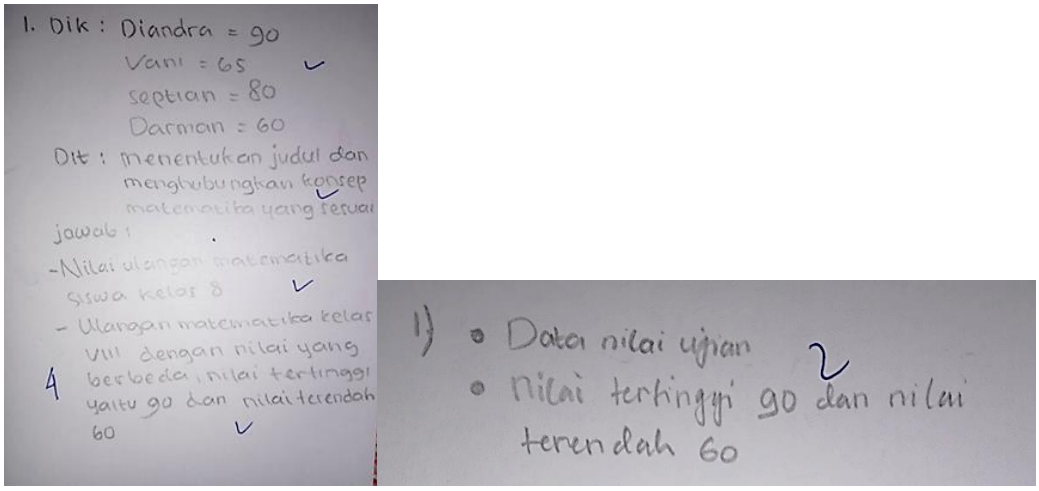

Figure 2. Students' answer S1 and S2

In the Figure 1, the results of student 1's work, the student has answered correctly as expected because the student completed it starting from what is known and asked and explained the conclusion according to the data in the question by stating that the highest score was achieved by Diandra, which is 90 and the lowest score was obtained by Darman, which is 60. The answer in the Figure 2, the results of student 2's work can be said to be correct or close to correct, because in question number 1 the student only concluded and completed the question based on the data provided.

The possibility of difficulty in question number 1 is very low because the question is relatively easy so that students are able to answer it, but are still less than perfect in drawing conclusions. This is because students are not careful in answering questions on the question and do not pay proper attention to the data provided. For example, students only conclude that question number 1 is the highest and lowest value data.

P: "What can you find out from the picture in question number 1?"
S-1: "Picture of a bar chart, ma'am."
P: "Apart from being a bar chart, is there anything else he knows from question number 1?"
S-1: "Yes ma'am, the chart is equipped with data. For example, like this, students named Diandra 90, Vani 70, Septian 80, and Darman 60."
P: "Okay. Is there anything else he knows?"
S-1: "No ma'am."
P: "From question number 1, what is asked?"
S-1: "You have to make a title ma'am and explain from the title I made."
P: "Well, you already know, right, what is known and asked, how do you solve the problem?"

S-1: "Just make a title ma'am that matches the bar chart. I'll take the title of the 8th grade math test scores."
P: "Okay. What conclusion can you draw?"
S-1: "In conclusion, the grade VIII math test with different scores, the highest score is 90 and the lowest score is 60."
P: "Did you have difficulty in working on question number 1?"
S-1: "No, ma'am."
P: "Are you sure?"
S-1: "Yes, ma'am."

From the interview above, it can be concluded that S-1 began to understand what was known and asked from the questions given and began to understand how to connect real objects, images, and diagrams into mathematical ideas.

The second question item with the indicator explaining real objects, images and diagrams in the form of ideas, situations, and relationships orally or in writing is as follows.

During the Covid-19 pandemic, the number of students who did not attend online learning at a school for ten consecutive days was as follows.

Days	1	2	3	4	5	6	7	8	9	10
Number of Absenteeism	12	14	17	20	21	12	10	8	6	4

Draw a line diagram from the data above and explain in your own words about the Covid-19 Pandemic that hit the school!

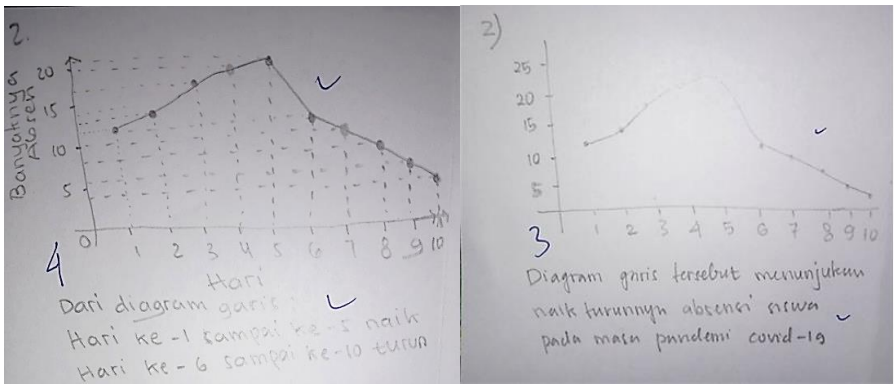

Figure 3. Students' answer S1 and S2

Student 1's answer is close to correct, because the student draws the diagram carefully. This is evident in connecting the coordinate points. So, that student 1's answer is close to the expected answer because he is able to draw conclusions based on the answer (See Figure 3).

Student 2's answer describes a line diagram without dotted lines so that the answer is incomplete. The horizontal line is not equipped with a description of the day, so it seems to answer the question carelessly and in a hurry. In terms of concluding, student 2 only

explains the rise and fall of absences that occurred during the Covid-19 pandemic without mentioning the amount of data (See Figure 3).

The obstacle faced in question number 2 is that students still have not mastered how to draw line diagrams properly. In this question, students are also required to conclude from what has been drawn previously, but in reality, students still have difficulty drawing conclusions correctly.

P: "What can you find out from question number 2?"
S-2: "A table showing attendance data during the Covid-19 pandemic, Ma'am."
P: "Okay. Is there anything else he knows?"
S-2: "No, Ma'am."
P: "From question number 2, what is he asking?"
S-2: "You have to make a line diagram, Ma'am, and you have to explain it from the line diagram that I made."
P: "Well, now you know what is known and what is being asked, how do you explain the solution to the question?"
S-2: "Just make a line diagram, Ma'am, that matches the data in the table."
P: "Okay. What conclusion can you draw?"
S-2: "The conclusion that I can draw is like this, Ma'am, from the line diagram it shows the rise and fall of student attendance during the Covid-19 pandemic."
P: "Are you sure about your conclusion?"
S-2: "Sure, Ma'am"
P: "Did you have difficulty working on question number 2?"
S-2 : "No ma'am."

Based on the interview above, it can be concluded that S-2 understands what is asked and is known from the questions given. Thus, S-2 can at least answer the questions even though based on the results of the analysis of the questions, S-2 is less precise in making graphs to draw conclusions.

The third question with an indicator stating daily events in mathematical symbol language is as follows.

The average score of 36 students in mathematics test is 86. There are four students who took the make-up test and got an average score of 80. Calculate the average score of all students!

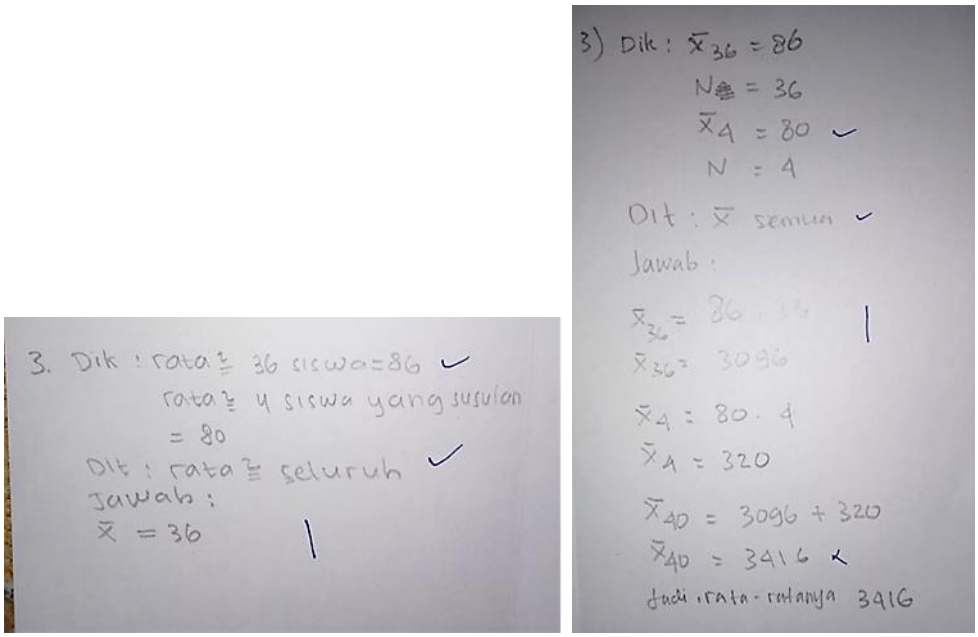

Figure 4. Students' answer S1 and S2

The picture answer from the results of student 1's work is still not correct, because the student only wrote what was known and asked, while the picture from the results of student 2's work is almost correct, but the student made a mistake in calculating the average value of all students and there was also an error in writing the symbol (See Figure 4).

The possible obstacle faced by students in question number 3 is that students have not fully mastered the formula for calculating the average value and the lack of student accuracy in writing mathematical symbols and how to calculate them.

P: "What can you find out from question number 3?"
S-1: "It is known that the average score of 36 students in the math test is 86 and four students who took the make-up test produced an average of 80, like that, Ma'am"
P: "Okay. Is there anything else he knows?"
S-1: "No, Ma'am."
P: "From question number 3, what is asked?"
S-1: "Must calculate the overall average score, Ma'am."
P: "Yes, that's right, now you know, what is known and asked, how do you solve it?"
S-1: "I don't understand, Ma'am, so I didn't fill it in."
P: "What made you not understand it?"
S-1: "Maybe you forgot the formula again, Ma'am."
P: "Oh, you forgot the formula again, so if you remember it, you can definitely do it, right?"
S-1: "Yes, Ma'am"
P: "Did you have difficulty in doing question number 3?"
S-1: "Yes, Ma'am. I don't really understand the problem, especially since I forgot the formula."

P: So if that's the case, you have to practice at home often so that you don't forget what you've learned. Do you understand?"
S-1: "Yes, I understand."
P: "Is that the only problem?"
S-1: "Yes, Ma'am."

Based on the interview above, S-1 had difficulty in working on the given questions. The reason was because he forgot the formula related to the question. In this case, S-1 has not been able to achieve the indicator of mathematical communication skills, namely stating everyday events in mathematical symbol language.

Discussion

Mathematical communication is a critical component of students' overall mathematical proficiency, especially in junior high school, where foundational concepts are solidified. When it comes to statistics, a branch of mathematics that deals with data collection, analysis, interpretation, and presentation, communication skills become even more essential. Statistics not only requires students to understand numerical data but also to express their understanding clearly and effectively.

In this study, we explored the mathematical communication skills of junior high school students within the context of statistics. The findings revealed several key insights into how students engage with statistical concepts and how effectively they communicate their understanding.

The ability to comprehend and process statistical information is the first step toward effective mathematical communication. The study showed that students who had a strong grasp of statistical concepts such as mean, median, mode, and data representation were more confident in communicating their findings. These students were able to describe their thought processes, justify their answers, and interpret statistical data with greater clarity. On the other hand, students who struggled with the basic concepts of statistics often had difficulty articulating their reasoning and explaining their answers.

One significant observation was the difference between students' written and oral communication skills. While some students excelled in writing detailed explanations of their statistical analyses, they found it challenging to verbally express the same ideas. Conversely, others could articulate their thoughts clearly in oral presentations but struggled to organize their ideas in writing. This discrepancy highlights the need for balanced instruction that fosters both oral and written communication skills, ensuring that students can effectively convey their understanding in multiple formats.

The study also underscored the importance of students using precise mathematical language when discussing statistics. Students who employed correct terminology and symbols were better able to communicate their ideas and engage in mathematical

discourse. However, many students tended to use informal or everyday language, which sometimes led to misunderstandings or inaccuracies in their communication. This finding suggests that educators should place greater emphasis on teaching and reinforcing the use of appropriate mathematical language in the context of statistics.

Visual representations, such as graphs and charts, are crucial tools in statistics. The study found that students who could accurately create and interpret visual data representations were more successful in communicating their findings. These students were able to link visual data to statistical concepts and explain the significance of their results clearly. However, students who lacked skills in interpreting visual data often faced challenges in communicating their statistical analyses. This indicates a need for instructional strategies that enhance students' abilities to work with and explain visual data.

The findings of this study have important implications for teaching and learning in mathematics education, particularly in the context of statistics. To improve students' mathematical communication skills, educators should integrate activities that encourage both oral and written expression. This could include collaborative group work, presentations, and written reports that require students to articulate their understanding of statistical concepts.

Moreover, educators should focus on developing students' ability to use precise mathematical language and to interpret and explain visual data. By doing so, students will not only improve their communication skills but also deepen their overall understanding of statistics.

In conclusion, the ability to communicate mathematical ideas effectively is vital for students' success in statistics. This study highlights the need for balanced and comprehensive instruction that addresses both the content knowledge of statistics and the communication skills required to express that knowledge. By fostering strong mathematical communication skills, educators can better prepare students for advanced mathematical thinking and problem-solving in their future academic and professional endeavors.

Conclusion

Based on the results and discussion, the researcher can conclude that students do not master the concept or material of statistics, students are less careful and thorough in solving mathematical communication skills problems, students' ability to draw conclusions is still relatively low, and students answer questions without providing clear reasons. Thus, referring to the results of the analysis of a sample of class VIII in one of the junior high schools where the researcher lives, it shows that the level of students' mathematical communication skills is in the category of lacking or still low.

Conflict of Interest

The authors declare that no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely by the authors.

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