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Verbal Mathematical Communication in Solving Sequence and Series Problem Based on Learning Style

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Abstract: The research aims to describe students' verbal mathematical communication skills in solving sequence and series problems, considering their visual, auditory, and kinesthetic learning style. The study addresses the issue that many students still struggle to express their thoughts on sequence and series problems. A qualitative approach is employed in this study, focusing on grade XI students who exhibit a dominant visual, auditory, and kinesthetic learning style. Data collection methods include a learning style assessment, a prerequisite test, and both oral test and written tests on mathematical problem-solving. Results from the oral and written tests are analyzed to characterize each student's verbal and written mathematical communication. Findings indicate that visual students struggle to verbally communicate mathematical ideas but are able to provide solutions and conclusions. Auditory learners, who excel at learning through listening, meet all indicators, effectively communicating mathematical ideas, presenting solutions, and making conclusions. Meanwhile, kinesthetic learners face challenges to satisfy one of the indicators, namely making conclusions but able to communicate mathematical ideas and provide the solution in their preferred way.

BACKGROUND

Shannon (1948) defines mathematical communication as how students receive the information such as mathematics problems and how they translate into the language of mathematics to express their ideas. According to Heale and Forbes (2013) mathematical communication is how students write or explain their mathematics ideas. Wilson (2009) stated that mathematical communication is the ability of students to understand mathematical ideas of the problem which can be seen on how students deliver their opinion or thoughts. Another definition of mathematical communication is that the mathematical communication is an activity which provide students the opportunities to share their answer of a mathematics problems (Chung et al., 2016). Hence, it can be argued that mathematical communication is a way for students to express mathematics ideas verbally or in writing.

The mathematical communication itself is divided into two kinds, namely written mathematical communication and verbal mathematical communication. The definition of written mathematical communication by Pantaleon et al (2018) is an activity that students express or explain their thought or opinion in the form of writing. While the definition of verbal communication is a use of audio to deliver ideas or message (Schruder, 2015).

Through verbal communication, students are trained to express ideas and understand mathematics by speaking directly in front of others. Therefore, written mathematical communication is an activity where students convey their answers or opinions in writing while verbal mathematical communication is an activity where students convey their answers or opinions orally.

According to Viseu and Oliveira (2012) mathematical communication is essential to enable students to express their mathematical ideas. But in fact, based on Triana et al (2019), students' ability in expressing mathematical ideas in form of oral is still lacking. Hutagaol (2013) also stated that students do not have enough opportunities to express their opinions; as a consequence, their verbal mathematical communication cannot be easily observed which leads to students quit. According to Viseu and Oliveira (2012) the lack of student's opportunities to express their opinions has the impact on their mathematical communication both in written or verbal which is affects their ability when faced with mathematics problems. Viseu and Oliveira (2012) stated that the delivery course material is mostly dominated by teacher explanation without giving students direct questions and opportunities to express their ideas. Therefore, student's mathematical communication cannot be observed.

The importance of understanding verbal mathematical communication in mathematics especially in solving mathematics problems according to Pantaleon et al (2018) is that teacher can measure how much students absorb the material and understanding the problems. According to Martinho and Ponte (2005), verbal mathematical communication brings up a process where the students interact, response information and express the ideas to other people, which highlights a purpose of learning. Vale and Barbosa (2015) stated that verbal mathematical communication is important in developing understanding of mathematical problems which is the purpose of learning mathematics. Another reason of understanding written and verbal mathematical communication to Elizabeth (2017) is that, it is important part of building mathematical ideas and answering mathematics problems. It can be argued that it is important to recognize verbal mathematical communication of the students because it is related with the purpose of mathematics learning.

One of the factors that could affects the mathematical communication is learning styles (Ignacio and Reyes, 2017). According to Vale and Barbosa (2015) students with different learning styles may present difficulties in understanding mathematical ideas when the only form of communication is written or only in verbal. Students who are able to communicate their ideas in written, not necessarily able to express their thought orally and vice versa. In accordance with Ignacio and Reyes (2017) learning styles is proven to give an important role in the learning process because it is how students begins to focus, process, internalize, and retain information. Dunn (2014) stated that learning style could be define as the way that people concentrate on, processes, and remember information. Abdillah (2022) also stated that different learning styles lead to different ways of solving problems. It can be argued

that each individual with their own preferred learning style will have the difference way of communicating and solving problems both written and verbal.

One of the mathematics topics taught to the students at the senior high school level is sequence and series. Isnani et al (2021) stated that there are still many students have not been able to convey their thoughts toward sequence and series problem. According to Qolbi et al (2022) the difficulty of students when working in sequence and series problems is that some of the students can explain the problems orally but they cannot write the steps to solve the problems. Zebua (2020) impress that the difficulty experience by students is when they have to share their mathematics ideas in an oral form. Students are not used to express their answers when asked directly by the teacher which leads into a lack of mathematical communication ability.

Lira Vazquez and Delfin (2017) found that mathematical communication is related to students learning style. Because students have their own preferred way to communicate and receive information from other people. According to El-Sabagh (2021) students are suffer from a lack of personal learning which happen in a classroom that is compatible with their learning style where the impact on their ability to solve problems is also different. Ilcin et al. (2018) stated that students learning style is related to their approach of studying which is related to how students solve problem. Based on El-Sabagh (2021), in current conventional learning environments, instruction has traditionally followed a "one style fits all" approach, which means that all students are exposed to the same learning procedures and this has the impact on how they communicate their ideas when they are solving the problems. Veiga et al (2014) suggest that there is a need for further research in assessing students' understanding by looking at their mathematical communication both in writing or orally. It is also important to clarify that learning style as a causal factor that effects their mathematical communication. Previous research only confirming students verbal mathematical communication by asking their written test result, whereas it is important to recognize their direct explanation especially when solving mathematics problems.

This research aims to describe student's verbal mathematical communication in solving sequence and series problem. Since students' mathematical communication is influenced by learning style, the students' communications, verbal and written, in this study is investigated based on students' learning style. Thus, the result gained from this research can give information for the teacher and can be a consideration in assessing students should not only look at the written one but also oral form. Thus, we can have better understanding on student's verbal mathematical communication.

METHOD

This study uses a qualitative research method in research. Creswell (2012) describe qualitative research is typically used to establish the importance of the central idea and to explore the problem and develop an understanding of small individuals in a certain case. As a conclusion, a qualitative approach used to explore the phenomenon in order to understand the practice and behaviour in real social situation for small individual. In

accordance with the purpose of this research, the result will give a description about verbal mathematical communication of visual, auditory, and kinesthetics students in solving sequence and series problem.

The research data were obtained from students of grade XI with the sampling technique used is purposive sampling. The participants were chosen based on specific characteristics: they were students of grade XI who had achieved high prerequisite test scores on sequence and series, and students who displayed a dominant learning style, as determined by a questionnaire distributed to assess learning preferences. The selected participants then underwent an oral test to gather data on their verbal mathematical communication skills.

RESULT AND DISCUSSION

The problem proposed in this research is about sequence and series. The participant is not only required to answer the problem but also communicate orally so that others can understand. The problem can be seen as follows: *I have a younger brother named Bimo. He wanted to add up all the page numbers in the book from page number 1 to page number 60. After counting, according to him, the number of all page numbers in the book was 1800. However, it turned out that there was one page that was missing which contained a gift card that was missing. He hasn't counted. Could you help my brother to find the page number that contains the gift card?*

The result of oral test after the participant being asked to the question can be seen on the transcript below.

Oral Test Result of Subject with Visual Learning Style

Students with visual learning style prefer to present information visually. It works best when there is an opportunity to express knowledge and present it in written form. This can be seen when given a sequence and series oral test, the subject does not immediately answer the questions but writes down something in a paper. The subject writes something which can be seen on the picture below.

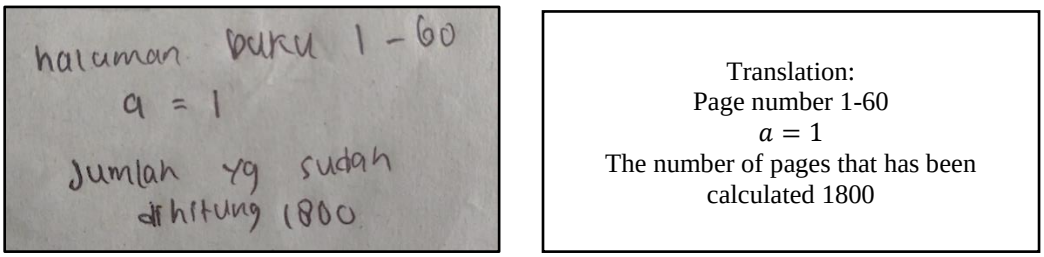

Figure 1. The Notes from Visual Subject While Listening to Question

Figure 1 is used as a tool for the subject in answering questions orally. SV wrote down something she knew when the questions were read by the researcher. The information that SV wrote down is the result of what she got after listening to the question orally. Subject writes pages 1 to 60, then writes a and the number that has been calculated is 1800. The subject's oral answer after listening to the question can be seen below.

So first, we have to find out how much S_n is in total or the the sum of page numbers 1 to 60 using the formula of sum of arithmetics sequence (pointing to her notes in figure 1). After getting the results, then the result is reduced by 1800(pointing to her notes) or S_n

which has been calculated by your brother. Because it is only one page to be searched, the result of the reduction is an uncounted page number.

Based on the result of the oral test of subject with visual learning style, SV is unable to explain the information given from the question. , SV is unable provide a mathematical ideas from the problem such how can it be interpreted that the page numbers in the book form an arithmetic sequence and mention what she will be looking for. After writing on her notes, SV is directly explained the solution or strategy to solve the problem which can be seen on the statement below.

So first, we have to find out how much S_n is in total or the the sum of page numbers 1 to 60 using the formula of sum of arithmetics sequence (pointing to her notes in figure 1). After getting the results, then the result is reduced by 1800(pointing to her notes) or S_n which has been calculated by your brother. Because it is only one page to be searched, the result of the reduction is an uncounted page number.

SV stated that the first step is to find out S_n which the sum of page number from 1 to 60 using the formula of sum of arithmetics sequence. and after getting the result, the uncounted page number is obtained from the reduction of S_n minus the page that has been calculated by the brother. From her statement, SV is able to mention the formula that will be used to find the unsummed page by using the sum of arithmetics formula. It could be said that SV is fulfill the second indicator of verbal mathematical communication, namely expressing the solution or strategy to solve the problem, but unable to fulfill the first indicator, namely communicate mathematical ideas.

After explaining the solution to find the page number that has not been added up, SV is unable to provide the conclusion of her thoughts. SV can provide an explanation of where the gift card is located by mentions the final result of the uncounted number. Even though SV is not giving the statement about the result is where the gift card is located, but SV said that the result of the reduction is an uncounted page number. It could be said that SV is fulfill the third indicator of verbal mathematical communication, namely making conclusion.

Oral Test Result of Subject with Auditory Learning Style

Subject with auditory learning style discover information through listening. These individuals gain knowledge from reading out loud in the classroom and may not have a full understanding of information that is written. The subject with auditory learning style is able to answer the problem without using the tool to help him understanding the problem, he only needs 3 minutes to think before explaining his ideas to the researcher. Here is the result of oral test of the auditory subject. So, in this problem it same with finding the terms that haven't been added up in an arithmetic sequence. The book has 60 pages, so it can be interpreted as a term in an arithmetic sequence because it was obvious that book has sequential pages.

I think we can name the page number that contains a gift card as variable or an alphabet. To find the variable, we can make an equation, namely the number of 60-page numbers

equals the number that already known in the problem plus the variable. We can find the sum of the 60-page numbers using S_n formula for the arithmetic sequence. After that, we can get the value of that variable. So that's, to find the page number that contains a gift card, your brother can make an equation first, that is, the number of 60-page numbers is the same as the number that has been counted plus the page we are looking for.

Auditory subject can explain the information of the problem given by the researcher. Before providing a solution to find the page containing the gift card, SA can change the problem into mathematical language, the SA states that the problem is about finding terms in an arithmetic sequence. Based on the table 4.5 the subject is able to communicate mathematical ideas that could be seen from his statement.

So, in this problem it same with finding the terms that haven't been added up in an arithmetic sequence. The book has 60 pages, so it can be interpreted as a term in an arithmetic sequence because it was obvious that book has sequential pages.

SA is able to define the information from the problem, since he said that this problem is about determining a term that has not been added up. SA also stated that the pages of a book is a sequential page therefore it can be imagined as an arithmetic sequence. SA also be able to name the page that contains a gift card as an alphabet, the thing that he will be find out in the problem. From those statement, it can be concluded that SA fulfill the first indicator of verbal mathematical communication, namely communicate mathematical ideas.

After explaining the mathematical ideas, SA can provide the solution to find the page containing the gift card by stating that he will use the sum of arithmetic series formula to calculate the total number of pages in the book, then the next step is to subtract the known number of pages in the question from the actual number of book pages. The statement that proves SA is able to expressing the solution can be seen in the following sentences:

> *SA : To find the variable, we can make an equation, namely the number of 60-page numbers equals the number that already known in the problem plus the variable. We can find the sum of the 60-page numbers using S_n formula for the arithmetic sequence. After that, we can get the value of that variable.*

SA stated that the solution to find the page is to make an equation, namely the sum of 60-page number is the same as the number calculated by the brother plus the unknown pages. From this statement, it could be said that SA meets the second indicator of verbal mathematical communication namely expressing the solution or strategy to find the answer.

The subject also can provide conclusions. SA said that to find the page that contains the gift card, the first is to make an equation, the number of 60 pages is equal to the known number plus the missing pages. From that statement, it could be said that the subject meets the third indicator of verbal mathematical communication, namely giving conclusion.

Oral Test Result of the Subject with Kinesthetics Learning Style

Individuals that are kinesthetics learn with an active "hands-on" approach. These learners favour interaction with the physical world. These characteristics can be seen when the subject with kinesthetics learning style answering the oral test using book as a tool to help them understanding the problem. The answer of student with kinesthetics learning style after listening to the question in table can be seen as follows.

SK : So, there was a book that has pages up to 60, right (Holding and opening the book). The sum of page numbers that has been counted by your brother is 1800. But there is a page number that contains a gift card that your brother looking for that has not yet known. So, for example, this is the page with the gift card, but we don't know what page number it is (holding on one of the pages in the book).
So, the ways are, all page number must be summed up, can using the formula of sum of arithmetic sequence. (opening and pointing the page number on the book). After getting the result, that amount is reduced by the total of page number that has been summed up by your brother.

Subject with kinesthetics learning style using a book and hand gesture to help her pointing what she wants to said to the researcher. According to the result or oral test of the subject with kinesthetics learning style, the subject can explain the mathematical ideas from the problem by the following statement:

SK : So, there was a book that has pages up to 60, right (Holding and opening the book). The sum of page numbers that has been counted by your brother is 1800. But there is a page number that contains a gift card that your brother looking for that has not yet known. So, for example, this is the page with the gift card, but we don't know what page number it is (holding on one of the pages in the book).

In explaining the information in the problem, SK using a book to help her to understand the question. The subject use hand gesture to pointing the page number that must be searched. SK also can explain the information from the problem which can be seen on her statements that the book has 60 pages, the amount of pages number that has been calculated is 1800, and the page number that she will looking for in this problem. It could be said that the subject can fulfill the first indicator of verbal mathematical communication, namely communicate mathematical ideas from the problem.

After SK explain about the information that she got from the question, SK also able to provide the solution to find the page number with gift card on it, which can be seen on her statement.

SK : So, the ways is, all page number must be summed up, can using the formula of sum of arithmetic sequence (opening and pointing the page number on the book). After getting the result, that amount is reduced by the total of page number that has been summed up by your brother.

SK said to find the unknown page number, all page number must be summed up. To sum up all pages, it can use the formula of sum of arithmetic sequence. After getting the result, it will be reduced by the total page number that has been summed up by the brother. SK at the end of her oral answer did not provide the conclusion. It could be said that SK is fulfill the second indicator of verbal mathematical communication, namely expressing the solution or strategy to solve the problem but unable to fulfill the third indicator of verbal mathematical communication, namely making conclusion.

According to the result of oral test of student with visual, auditory, and kinesthetics, each subject with their preferred learning style shows the difference in communicating ideas, providing solutions, and also making conclusions on a sequence and series oral test. The student with auditory learning style able to communicate mathematical ideas directly without making notes or using tool to help him to understand while the kinesthetics students able to communicate mathematical ideas using tool in form of book to help him explaining their thoughts. The difference can also be found on how each subject expressing the solution to find the page that contains a gift card. Subject with visual learning style uses

his notes to explain the solution he is talking about when answering questions, the auditory subject directly explains the solution without using notes or objects to help him explaining the solution, while the kinesthetic subject uses an object in the form of a book to describe the solution used to find the page number of the book.

Based on the results of the oral test, it was found that there were some differences in how the participant communicated orally towards sequence and series problem. Those differences in how the participant communicate based on their learning style, will be discuss in this section. The first will be discussed about oral mathematical communication of students with visual, auditory, and kinesthetics learning style. And the second, will be discussed about written mathematical communication.

In this section, the participant of visual, auditory, and kinesthetics learning style will be described on how they are able or unable to fulfill the indicator of oral mathematical communication.

Communicating Mathematical Ideas

This indicator asks students to be able to memorize and explain what is understood from the problem which was given by the researcher. In other words, students must be able to provide an opinion in a more understandable form. As reported by Wilson (2009), communicating mathematical ideas orally is not an easy task for the students. This is because each students have different ways to communicate which leads to a different response in explaining what is understood.

Based on the result of oral mathematical communication of the participant with visual, auditory, and kinesthetics learning style it was found some difference on how they communicating and answering the question given by researcher. Visual participant unable to satisfy the first indicator of verbal mathematical communication, namely communicate mathematical ideas. SV needs to write notes after listening to the question before explaining her answer. It could be said that SV needs to visualize the problem in order to help them understanding the problem because individual with visual learning style depend more on the information in form of visual which leads them to unable to communicate the information after they listen to the question. This is in accordance with the characteristics of participant with visual learning style according to Metallidou and Platsidou (2008) that visual learner understands the problem from what they seen. SV unable to communicate the mathematical ideas from the problem such as explaining what is known from the problem, rather she directly expressing the solution to find the missing page.

While the participant with auditory learning style, can fulfill the first indicator of verbal mathematical communication which can be seen on how he able to identify the information from the problem such as explaining that the problem is about determining a term that has not been added up. SA also stated that the pages of a book is a sequential page therefore it can be imagined as an arithmetic sequence. SA also be able to name the page that contains a gift card as an alphabet, the thing that he will be find out in the problem. According to Xing (2023), participant with auditory learning style very sensitive to voice and rhythms

and this can be seen on how SA is able to mention the information and transform into mathematical language after being asked. SA did not take a long time answering the question after being asked orally. This is also consistent with the characteristics of the auditory learning style explained by Xing (2023), they are excellence in getting the information in the form of audio or voice.

The participant with kinesthetics learning style able to fulfill the first indicator of verbal mathematical communication by explaining the information using a book to help her to communicate the mathematical ideas. Gantasala (2009) stated that students with kinesthetics learning style prefer to use hand gesture and expression to communicate with other people. That things can be seen on how SK using the book to pointing the page number and slide the page to show the information contains from a book. Individual with kinesthetic learning styles learn best when they are permitted to use their tactile senses to explain the information to other people.

It can be concluded that the participant with visual learning style is not fulfill the first indicator of oral mathematical communication, while the participant with auditory and kinesthetics learning style are able to fulfill the first indicator of oral mathematical communication by explaining the problem orally with their difference way of communication. The auditory participant is explaining his ideas directly while the kinesthetics participant explaining their ideas using a tool. This is in accordance with the Metallidou and Platsidou (2008) statement that individual with auditory learn with speaking and listening while the kinesthetics learn by touching and doing.

Expressing the Solution or Strategy

This indicator asks students to be able to provide the steps that will be used to solve the problem. In delivering the solution or strategy, it was found that each participant uses different ways to communicate to find the page which contains a gift card. From the result of oral test, the participant with visual learning style giving the solution by telling that the first step is to find the sum of the total page number on the book while she is pointing to her small notes which contains the information she got after listening to the question. In delivering the solution, she is speaking while pointing to her notes to make the researcher understand. This characteristic is in accordance with the statement by Gilakjani (2012) that induvial that are visual prefer to take descriptive notes when they are learning. This thing can be seen on the figure 4.2 that the participant is writing some information on a small note when they are given the question orally. This note is use as a thing that can help the participant to visualize the problem because individual with visual learning style is learning by seeing (Arora, 2019). It can be concluded that the visual participant is fulfill the second indicator of verbal mathematical communication namely, expressing the solution.

The participant with auditory learning style is also be able to provide the solution by speaking his ideas directly without using a tool or thing to help him in expressing the steps to find the missing page. According to Cohen and Wolvin (2011) individual with auditory learning style learn best when they are listening to a problem in form of audio. The problem

given by the researcher in form of oral can facilitate them to think according to their preferred learning style because they are learning with listening. This is in accordance with the statement by Cohen and Wolvin (2011) that auditory students prefer to learn by listening to the material. This characteristic can be seen on how the auditory participant is able to give the solution orally. The solution that auditory participants provide is by making an equation namely, the sum of 60-page number is equal to the sum that has been calculated by the brother plus the page that will be looking for. It can be concluded that the auditory participant is fulfill the second indicator of written mathematical communication.

For the participant with kinesthetics learning style, she can mention the formula and the steps that will be used to find the missing page while she also using a book learn and express her solution. In explaining the way to find the page that contains a gift card, the kinesthetics participant said all page number must be summed up using the formula of sum of arithmetic sequence. The kinesthetics participant is mostly used hand gesture to help her speaking the solution. According to Arora (2019) kinesthetics student prefer to learn using their physical movement and be able to memorize something using a tool to help them in understanding the problem. That things could be seen when the kinesthetics participant providing the solution while she also opening the book and pointing to the page number on the book. She asks permission to the researcher to take a book before answering to the problem.

Each learning style has their own preferred way in expressing sequence and series problem. The participant with visual learning style used notes to explain the solution to the researcher, the auditory participant is telling the solution directly, while the kinesthetics participant is using a book and lot of hand gesture to explain the solution. It can be concluded that all the participant is able to find the steps in solving the problem and fulfill the third indicator of verbal mathematical communication.

Conclusion

Conclusion is a final step which consist an argument or statement about the result of the answer. Students is asking to be able to provide the conclusion by explaining about their thoughts. From the oral test result, there were some differences that will be explained. Visual participant be able to give the final statement which states that the result of the calculation is the uncounted page number. According Kia, et all (2009), the way the teacher gives the opportunity to the student to learn in their preferred way will directly influence in how students answering the question. This thing can be seen from the use of notes which can help the participant to communicate the solution which can lead her to make the final statement of the result because individual with visual learning style memorize and learn by seeing. It can be concluded that the participant is fulfill the third indicator of verbal mathematical communication.

The conclusion that was made from the auditory participant contains the summary of the steps to find the answer. Participant with auditory learning style is able to fulfill the third indicator of verbal mathematical communication by giving the statement directly. But participant with kinesthetics learning style is unable to make a conclusion because the

question is asked in form of oral while the individual with kinesthetics learning style is lacking to understand and learn by listening (Kia et al 2009). The way the researcher giving the problem orally is influence the kinesthetics participant unable to memorize the problem. It can be concluded that kinesthetic participant is unbale to fulfill the third indicator of verbal mathematical communication.

CONCLUSION AND SUGGESTIONS

The result of the oral test that has been describe in has shown that each learning style has different way in expressing their ideas orally which has an impact on whether or not they are satisfied with the verbal mathematical communication. This difference is caused by their characteristics in learning and understanding something. Giving questions orally, will bring up different responses, participant with visual learning style is different from the auditory and kinesthetics and vice versa. Those different response will lead to whether or not the participant satisfied the indicator of verbal mathematical communication

Participant with visual learning style is able to provide the solution or strategy to solve the sequence and series problem and giving the conclusion but unable communicate the information which exist in the problem after the question is given. It can be concluded that the visual participant is satisfied the second and third indicator of written mathematical communication, namely expressing the solution or strategy to solve the problem. Visual students are excellence in learning something presented in visual form, so that's why the question in form of oral makes them difficult to visualize the problem which leads to not satisfying the first indicator or verbal mathematical communication. For the participant with auditory learning style, the participant is able to fulfil all the indicators of verbal mathematical communication. This is because the participant with auditory learning style learns best by listening to the problem and telling the ideas he wants to share. The problem in form of oral can also facilitate them to learn by listening. While the participant with kinesthetic learning style is able to fulfil the first and second indicator of verbal mathematical communication by speaking to the researcher using a tool to help them understand the problem and provide the solution using hand gesture.

The difference on how the participant answering the question given by the researcher is in accordance with their characteristics. The characteristics of visual participant is that she prefers using something in form of written which in this case can be seen on the notes used by the participant. Because the characteristics of visual students is learning by seeing. While the auditory participant is able to provide the solution without using any notes of a tool because they are excellence in learning by listening and telling their ideas to others. The difference in providing the solution can also be found in kinesthetic participant namely, using a tool in order to facilitate their thinking process to understand the problem and to facilitate their use of physical movement such as hand gesture.

Based on the research results obtained from the data in the field, the research is going well. But the researcher wants to put forward some suggestions that hopefully will be useful for the advancement of the mathematical communication in a classroom. Considering that

students have different styles of mathematical communication, it is necessary for the teachers to provide the daily tasks or assignments not only in written form but also in oral form. This approach allows students to express their ideas in their preferred way. It is essential for the students to recognize any weaknesses in their ability to communicate mathematical ideas effectively. Particularly when delivering correct mathematical equations, to avoid misinterpretation by others. Teachers should present math problems related to everyday life, enabling students to practice their mathematical communication skills. Students must continually encourage themselves to practice solving mathematical problems. This will help them translate information into mathematical language and provide logical reasoning for their solutions.

REFERENCES

Brouwers, S. A., Van de Vijver, F. J. R., & Van Hemert, D. A. (2009). Variation in Raven's Progressive Matrices scores across time and place. *Learning and Individual Differences*, *19*(3), 330–338. https://doi.org/https://doi.org/10.1016/j.lindif.2008.10.006

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020). Purposive sampling: complex or simple? Research case examples. *Journal of Research in Nursing : JRN*, *25*(8), 652–661. https://doi.org/10.1177/1744987120927206

Cassidy, S. (2004). Learning styles: An overview of theories, models, and measures. *Educational Psychology*, *24*(4), 419–444. https://doi.org/10.1080/0144341042000228834

Chislett, V., & Chapman, A. (2005). VAK Learning Styles Self-Assessment Questionnaire. In *Www.Businessballs.Com*.

Chung, Y., Yoo, J., Kim, S.-W., Lee, H., & Zeidler, D. L. (2016). ENHANCING STUDENTS' COMMUNICATION SKILLS IN THE SCIENCE CLASSROOM THROUGH SOCIOSCIENTIFIC ISSUES. *International Journal of Science and Mathematics Education*, *14*(1), 1–27. https://doi.org/10.1007/s10763-014-9557-6

Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). *Learning Styles and Pedagogy in post-16 learning: a systematic and critical review*. Learning and Skills Research Centre.

Cohen, S. D., & Wolvin, A. D. (2011). Listening Education. *Listening Education*, *2*, 16–25.

Creswell, J. W. (2012). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research*. Pearson.

Cropley, A. (2015). *Introduction to Qualitative Research Methods*. https://doi.org/10.13140/RG.2.1.3095.6888/1

El-Sabagh, H. A. (2021). Adaptive e-learning environment based on learning styles and its impact on development students' engagement. *International Journal of Educational Technology in Higher Education*, *18*. https://doi.org/10.1186/s41239-021-00289-4

Faires, J. D. (2006). Sequences and Series. In *First Steps for Math Olympians: Using the American Mathematics Competitions* (pp. 127–134). Mathematical Association of America. https://doi.org/https://doi.org/10.5948/9781614444046.013

Ferri, R. B. (2012). MATHEMATICAL THINKING STYLES AND THEIR INFLUENCE ON TEACHING AND LEARNING MATHEMATICS. *12th International Congress on Mathematical Education*. http://www.icme12.org/upload/submission/1905_f.pdf

Greenes, C., & Schulman, L. (1996). Communication Processes in Mathematical Explorations and Investigations. In P. C. Elliott & M. J. Kenney (Eds.), *1996 Yearbook: Communication in Mathematics, K-12 and Beyond*. NCTM.

Heale, R., & Forbes, D. (2013). Understanding triangulation in research. *Evidence-Based Nursing*, *16*(4), 98. https://doi.org/10.1136/eb-2013-101494

Hirschfeld-Cotton, K. (2008). Mathematical Communication, Conceptual Understanding, and Students' Attitudes Toward Mathematics. *Action Research Projects*, *4*. http://digitalcommons.unl.edu/mathmidactionresearch/4

Ignacio, J. A. G., & Reyes, J. D. (2017). Exploring Mathematics Achievement Goals Using Kolb's Learning Style Model. *Asia Pacific Journal of Multidisciplinary Research*, *5*(1), 19–24. www.apjmr.com

İlçin, N., Tomruk, M., Yeşilyaprak, S. S., Karadibak, D., & Savcı, S. (2018). The relationship between learning styles and academic performance in TURKISH physiotherapy students. *BMC Medical Education*, *18*(1), 291. https://doi.org/10.1186/s12909-018-1400-2

Lira Vazquez, A., & Delfin, R. T. (2017). Learning Styles in High School Mathematics. *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)*, *31*(1), 207–213.

Peterson, C. (2003). Bringing ADDIE to Life: Instructional Design at Its Best. *Journal of Educatioanal Multimedia and Hypermedia*, *12*(3), 227–241. http://www.learntechlib.org/p/2074/

Rose, C. (2020). *Accelerated Learning For the 21 ST Century*. Nuansa Cendekia.