Student’s mathematical communication ability based on Kolb’s learning styles of assimilator and accommodator type

E Rohmanawati1*, T A Kusmayadi2, and L Fitriana3

1Postgraduate Program of Mathematics Education, Universitas Sebelas Maret, Jalan Ir. Sutami No. 36A, Surakarta 57126, Indonesia
2Faculty of Mathematics and Natural Sciences, Universitas Sebelas Maret, Jalan Ir. Sutami No. 36A, Surakarta 57126, Indonesia
3Faculty of Teacher Training and Education, Universitas Sebelas Maret, Jalan Ir. Sutami No. 36A, Surakarta 57126, Indonesia

*evirohmanawati2@gmail.com

Abstract. Mathematical communication has an important role in the problem solving process. One factor that can support mathematical communication skills is learning style. It is important for teachers to analyze their students learning styles, so that the information obtained can help to be more sensitive in understanding differences in class and can make learning more meaningful. This research aims to describe a mathematical communication of students based on Kolb’s learning styles of assimilator and accommodator type. This research used a qualitative descriptive method. The subjects of this research consisted of two Junior High School students who were selected using purposive sampling. The instruments used in this research were tests and questionnaires, while the data validity used the triangulation method. The data analysis was performed through data collection, data reduction, data presentation, and conclusion. The research result shows that the assimilator type students were able to describing the problem situation in the form of geometry and using mathematical solutions related to the analysis of other forms. While the student with accommodator type can investigate about what is known and describes the problem situation in the form of geometry.

1. Introduction
Math is one of the subjects that must be studied at each school level. Mathematics learning material in schools consists of concepts, symbols, formulas, numbers, and letters that are still abstracts and need explanation [1]. Mathematics is not only a tool for thinking, a tool for finding patterns, or solving problems, but also as a good tool for communicating ideas so they are clear, precise, and concise [2]. Students are expected to be able to change problems into mathematical language, to solve it logically, critically, and rationally, and then be able to communicate the solution clearly, both verbally and in writing [3]. Communication is a process of transmission of information, ideas, and others through the use of symbols such as words, pictures, numbers, and others [4]. Communication is an important part of mathematics and mathematics learning because, through communication, students can filter ideas and clarify their understanding. If every student has good mathematical communication ability, then abstract concepts can be easily understood in learning activities. Nonetheless, in reality, students’ mathematical communication ability is still low. Students are facing difficulty in expressing their ideas when they are solving mathematical problems.
The mathematical communication ability of students could be enhanced if teachers could identify their students’ characteristics in learning activity [5]. Students must have different levels of ability in understand and absorbing learning materials. The differences could affect the way students in gaining information while studying. One of the factors that could enhance the ability of mathematical communication is learning styles [6]. Learning styles is already proven to give an important role in the learning process [7]. Teachers play an important role in the continuity of the teaching and learning process to achieve quality learning goals. Teachers need to analyze their students’ learning styles to obtain information that could help them to be more heedful in understanding differences in the class and could perform more meaningful learning. When students’ learning styles and teacher’s learning styles do not match, students will be uncomfortable, bored, and neglectful in the class, this could make the students’ interest in learning to be wear off.

Learning styles is a way of someone in accepting, absorbing, and processing information [8]. One of the learning styles that emphasize the information processing and concrete experience of the learning process is a learning style that was popularized by David Kolb, which is Kolb’s learning styles. Kolb’s learning styles is the most applied in mathematics learning, especially to solve problems with approaches in constructing concept formation strategies [9]. Kolb’s learning styles consist of four types which are converger, diverger, assimilator, and accommodator [10]. A person who learns from their previous experience is called a concrete experience. That experience was observed well through abstract conceptualization, then thought out to produce a conclusion or conjecture called reflective observation, and the conclusion was tested by trying to do an action through active experiment [11], and so on that this cycle will be repeated.

The result of the research that was conducted by Daimaturrohmatin and Rufiana shows that each type of Kolb’s learning styles has different mathematical communication abilities [12]. Based on that study, researchers were interested in describing and explaining mathematical communication ability that the students have based on assimilator and accommodator types of Kolb’s learning styles.

2. Methods
This research used the qualitative descriptive method. This research was conducted on 8th grade students of a public Junior High School in Sleman in the academic year of 2019/2020. This research used a purposive sampling technique. The purposes of selecting subjects with a purposive sampling technique are researchers can choose individuals as the subject of research and to understand the phenomenon on the research focus [13]. The subject of this research consists of two students representing the assimilator and accommodator types of learning styles.

The instruments used in this research were Kolb’s learning style questionnaire and a mathematical communication test. The questionnaire used to find out the students’ type of learning styles. Mathematical communication tests used to find out students’ mathematical communication ability in solving mathematical problems. Mathematical communication in this research is limited to written mathematical communication ability with indicators taken from the mathematical communication framework developed by Brenner [14]. The description of the mathematical communication indicators used in this study is shown in Table 1.

| No | The Mathematical Communication Indicators | The Sub Indicators |
|----|------------------------------------------|--------------------|
| 1. | Problem-solving tool                     | 1) Investigating what is known in the problem  
|    |                                          | 2) Investigating what is asked in the problem |
| 2. | Representation                           | 1) Describing the problem situation in the form of geometry |
| 3. | Alternative solution                     | 1) Using mathematical solutions related to other forms of analysis  
|    |                                          | 2) Writing a conclusion of the solution to the problem |
Data that has been obtained and collected in the field must be guaranteed validity and correctness. Therefore, the validity of this study obtained through triangulation. The data analysis was performed through data collection, data reduction, data presentation, and conclusion. Data reduction is to summarize, choose the main points and get rid of what is not important. Presentation of data uses a brief description, chart or relationship between categories or the like.

3. Result and Discussion
The results of the Kolb’s learning styles questionnaire that have been obtained are used to classify students based on each type of their learning style. This research focused on assimilator and accommodator types of learning styles. The results of students’ mathematical communication tests based on Kolb’s learning style are shown as follows.

3.1. Assimilator
Assimilator learning styles combining reflective observation and abstract conceptualization learning approaches. Assimilator learning styles tend to be more theoretical, thinking analytically, orderly, and systematically [15]. The subject with assimilator type of learning styles in this research is subject S1. The results of the S1’s work are as follows.

Based on Figure 1, the result of subject S1 work (S1Q1), with assimilator type of learning styles, shows that the subject can represent ideas from the problem in the form of drawing, correctly. The student with the assimilator type of learning styles tends to focus on ideas [16]. This means the representation of the indicator is well-fulfilled. Nonetheless, the problem-solving tool is not fulfilled since the subject did not investigate what was known and stated from the problem in the form of symbols or mathematical notation. In the alternative solution indicator, the subject could explain the relation of mathematical ideas from the drawing that have been made to solve the problem according to mathematical rules but did not write the conclusion of the problem solution. The subject can resolve the problem with coherent and systematic problem-solving steps. The student with assimilator type of learning styles has a good ability to present ideas and to define a problem [17].
Based on Figure 2, the result of the subject’s work (S1Q2), shows that the subject did not investigate what is known and stated from the problem in the form of symbols or mathematical notation. Therefore the problem-solving tool indicator is not fulfilled. In the representation indicator, the subject represented the ideas in the form of drawing, well. In the alternative solution indicator, the subject correctly finds the length of common tangent between two circles. The completion procedure used by the subject is true and correct. Nonetheless, the shaded area in the drawing is not quite right. This could result in the mistake in applying a formula to determine the shaded area region.

3.2. Accommodator
The accommodator learning style combines an active experiment and a concrete experience learning approach. Accommodator learning style is able to connect learning with real-life, carry out plans in real situations, and directly involves in new experiences [18]. The subject with the accommodator learning style in this research is Subject S2. The results of Subject S2 work as follows.

Based on Figure 3, the result of subject S2 work (S2Q1), shows that the subject understood what is known in the problem and wrote it down in mathematical notation, well. Nonetheless, the subject did not investigate what was asked of the problem. This could result in a misunderstanding of the concept to be used later. In the representation indicator, the subject represented ideas in the form of drawing, correctly. In the alternative solution indicator, the used problem-solving procedure was not right. The
subject made a mistake in understanding the concept of the tangent of two circles, so the used formula was also wrong. Generally, students with an accommodator learning style prefer field learning, and they are not good at learning concepts [19].

![Figure 4. Accommodator student’s answer question 2 (S2Q2)](image)

Based on Figure 4, the work result of the subject (S2Q2), shows that the subject understood what’s known in the problem and stated in mathematical notation. But did not investigate what was stated in the problem. In the representation indicator, the subject presented ideas in a form of drawing, well. In the alternative solution indicator, in solving the problem, the subject made a mistake in understanding the concept and did not analyze the drawing well. Students with accommodator type learning styles do not prioritize the power of logical analysis [20].

Based on the analysis described, it can be seen that students’ mathematical communication abilities are influenced by learning styles. Subjects with assimilator type can use mathematical solutions related to other forms of analysis. However, they experience a slight error in understanding the concept of shaded area region at the final stage of completion while subjects with accommodator types have difficulty understanding the concepts and resolution procedures used to solve mathematical problems. This is in agreement with research conducted by Iftinan, Maharani and Ubaidah, which states that students with an assimilator type lack understanding of concepts in final decision making, and students with accommodator type need to explain various ways of solving mathematical problems [21].

4. Conclusion

Based on the research and the discussion, it can be concluded that Kolb’s learning styles greatly affect students’ mathematical communication skills ability. Every type of learning styles of students has different mathematical communication ability. The result shows that the subject with the assimilator type of learning styles more mastered in terms of describing the problem situation in the form of geometry and using mathematical solutions related to the analysis of other forms while the subject with accommodator type of learning styles more mastered in investigating what is known and describe the problem situation in the form of geometry.

5. References

[1] Reys R, Reys B, Lapan R, Holliday G and Wasman D 2003 Assessing The Impact of Standards Based Middle Grades Mathematics Curriculum Materials on Student Achievement Journal for Research in Mathematics Education 34(1) 74-95

[2] Baroody A J 1993 Problem Solving, Reasoning, and Communicating, K-8 Helping Children Think Mathematically (New York: Macmillan Publishing Company)

[3] Winarso W 2018 Authentic Assessment for Academic Performance; Study on The Attitudes, Skills, and Knowledge of Grade 8 Mathematics Students Malikussaleh Journal of Mathematics Learning 1(1) 1-8
[4] Tinungki G M 2015 The Role of Cooperative Learning Type Team Assisted Individualization to Improve the Students: Mathematics Communication Ability in the Subject of Probability Theory Journal of Education and Practice 6(2) 27-31
[5] Winarso W 2015 Perbedaan Tipe Kepribadian Terhadap Sikap Belajar Matematika Siswa Kelas X SMA Islam Al-Azhar 5 Cirebon Jurnal Sainsmat 4(1) 67-80
[6] Sari I P 2017 Kemampuan Komunikasi Matematika Berdasarkan Perbedaan Gaya Belajar Siswa Kelas X SMA Negeri 6 Wago Pada Materi Statistika Jurnal Nalar Pendidikan 5(2) 527-533
[7] Mousa N 2014 The Importance of Learning Styles in Education International Journal of Education 1(2) 19-27
[8] Ignacio and Reyes 2017 Exploring Mathematics Achievement Goals Using Kolb’s Learning Style Model Asia Pasific Journal of Multidisciplinary Research 5(1) 19-24
[9] Knisley J 2001 A Four-Stage Model of Mathematical Learning The Mathematics Educator 12(1) 11-16
[10] Kolb A Y and Kolb D A 2005 The Kolb Learning Style Inventory - Version 3.1 Technical Specifications (Boston: Hay Resources Direct)
[11] Kolb D A 2014 Experiential Learning: Experience as The Source of Learning and Development (Englewood Cliffs New Jersey: Prentice Hall)
[12] Daimaturrohmatin dan Rufiana I S 2019 Analisis Kemampuan Komunikasi Matematis Siswa Ditinjau dari Gaya Belajar Kolb Artikel Ilmiah Mahasiswa Universitas Muhammadiyah Ponorogo 3(1) 17-31
[13] Creswell J W 2012 Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research (Upper Saddler River: Pearson Education, Inc)
[14] Brenner M E 1998 Development of Mathematical Communication in Problem Solving Groups by Language Minority Students Journal of Bilingual Research 22(4) 103-128
[15] Ghufron M N dan Risnawati R 2012 Gaya Belajar (Yogyakarta: Pustaka Pelajar)
[16] Richmond A S and Cummings R 2005 Implementing Kolb’s Learning Styles into Online Distance Education International Journal of Technology in Teaching and Learning 1(1) 45-54
[17] Gooden D J, Preziosi R C and Barnes F B 2009 An Examination of Kolb’s Learning Style Inventory American Journal of Business Education 2(3) 57-62
[18] Mountford H, Jones S and Tucker B 2006 Learning Styles of Entry-Level Physiotherapy Students Journal Advances in Physiotherapy 8(3) 128-136
[19] Ramlah, Firmansyah D dan Zubair H 2014 Pengaruh Gaya Belajar dan Keaktifan Siswa Terhadap Prestasi Belajar Matematika Jurnal Ilmiah Solusi 1(3) 68-75
[20] Azrai E P, Ernawati dan Sulistianingrum G 2017 Pengaruh Gaya Belajar David Kolb (Diverger, Assimilator, Converger, Accommodator) Terhadap Hasil Belajar Siswa pada Materi Pencemaran Lingkungan Jurnal Pendidikan Biologi 10(1) 9-16
[21] Iftinan N, Maharani H R dan Ubaidah N 2019 Analisis Kemampuan Berpikir Kritis Siswa Ditinjau dari Gaya Belajar Tipe Kolb Pada Materi Bilangan Bulat Prosiding Konferensi Ilmiah Mahasiswa Universitas Islam Sultan Agung 2 638-646

Acknowledgments
Researchers would like to thank the referees for improving the quality of this article. The researchers are grateful to the public Junior High School in Sleman that has allowed conducting the retrieval of research data.