Assessing misconception reasoning and communication statistical about variability among Madrasah Tsanawiyah students

Iyam Maryati1,2,a and Nanang Priatna3,b
1Sekolah Tinggi Keguruan dan Ilmu Pendidikan Garut, 44151, Garut, West Java, Indonesia
2Departemen of Mathematics Education, Postgraduate Student, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi 229, Bandung 40154, Indonesia
3Lecturer of Postgraduate Departement of Mathematics Education, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudhi 229, Bandung 40154, Indonesia
E-mail: amaryati_iyam@student.upi.edu, bnanang_priatna@ui.edu

Abstract. This study aims to identify misunderstandings in reasoning and statistical communication about the variability among students’ class VIII Madrasah Tsanawiyah State Garut Indonesia. In this study, the test of reasoning and statistical communication each consisting of 5 pieces of questions conducted on 37 students. The results showed that 47% of students get values below the minimum value of mastery. There are four misconceptions found in this study. Recommendations given in this study to help overcome misconceptions in understanding variability.

1. Introduction
In our national education curriculum, statistical learning materials have been given ranging from elementary school level to college level. This statistical material is integrated into mathematics subjects given at elementary school level up to high school. While in college statistics studied in a special course. In the statistical material given to junior high school students 8th grade, students are required to be able to present data in bar charts, lines, and circles. This ability is very useful for students in understanding data information. In daily life, many data are presented in the form of diagrams. For example, when students enter the administrative room they see on the diagram board the number of students, teachers, and employees who are in school. They will be able to understand the information if they have the ability to present data in the form of diagrams. The ability to present this data is the ability of reasoning and statistical communication.

But in understanding the statistical ideas in the information content often students understand less than perfect. This can be seen when students solve statistical problems that are not complete. This unfulfillment is thought to be due to a lack of student ability in presenting statistical ideas orally, in writing, tables, graphs, and diagrams. The inability of students in presenting data or statistical ideas that can be seen from the results of formative replication is still low. The purpose of this study is to describe learning difficulties in understanding data or statistical ideas on Madrasah Tsanawiyah students in terms of statistical communication and reasoning ability.
2. Theoretical Study
According to [1] stating statistical reasoning is the way a person works by using statistical ideas and understanding statistical information. Whereas [2] explains that statistical reasoning involves interpretation of decisions based on the data set, data representation, or summary statistical data. [3] Based on his research states in understanding and improving students' statistical reasoning, done by integrating three approaches, namely theoretical study approach, empirical studies, and classroom-based research. [4] The ability of statistical reasoning is the ability to draw conclusions and provide explanations based on data orientation with respect to structured procedures, unstructured procedures, and statistical concepts and provide critical comments on a process or statistical outcome. According to [5] in the literature review argues that the ability of statistical reasoning is the ability to understand the information in daily life based on data or ideas that means the ability to understand how to choose, present, reduce, and present data used in the existing problem.

The ability of statistical communication as a process of building statistical knowledge can also be developed in introductory learning statistics. According to [6] that despite recommendations for the creation of a vision of mathematics teaching is emphasized on problem-solving abilities, reasoning, and proof. An important aspect of mathematical communication skills is the ability to communicate concepts and outcomes in written and oral form. [7] that everyone's communication skills in reading, writing, demonstrating, and demonstrating statistical information.

In this study, the ability of statistical reasoning and statistical communication ability is measured simultaneously. In the standard content of subjects of mathematics SMP/MTs, core competence consists of ability: 1) concept understanding, 2) reasoning, 3) communication, 4) problem solving, and 5) appreciation on the usefulness of mathematics. These competencies constitute a unified whole keeping in mind that competence is defined as a unanimous knowledge, skills and attitudes mean that the five aims are one unity. [8] Indicators in achieving reasoning and communication abilities are: 1) present statements with oral, writing, graphs, tables, and diagrams, 2) suggesting, 3) manipulating, 4) compiling evidence, giving reasons or evidence of the truth of the solution, 5) drawing conclusions from the statement, 6) checking the validity of an argument, 6) finding the pattern or the nature of the statistical symptoms to make generalizations.

3. Methodology
This type of research is descriptive qualitative research. The research data was obtained from 37 students of 8th-grade academic year 2016/2017 Madrasah Tsanawiyah Garut. To collect information about students' difficulties in the statistical material is derived from the results of tests of reasoning ability and statistical communication. Testing the validity of this instrument using the validity of the content, namely testing validity by using the instrument grid in which there is an indicator as benchmark and number of questions that have been described from the indicator. Which instrument in the form of questions will be tested validity back, then consulted to the expert. In This study, the expert in question is a lecturer and a teacher of mathematics class VII B at Madrasah Tsanawiyah Garut. Instrument Validation is a matter of which has been consulted, revised, and then approved to be given to students as test to do. Problem description given to students includes 5 numbers with a grid as following.

| Standard Competence | Competence Basic | Indicator | Information |
|---------------------|-----------------|-----------|-------------|
| processing data     | Processing data | Students can process data already presented (Mean, Median, Modus) | Question no 1 & 2 |

Table 1. Grid Instrument Test
Presentation data

a. Data in form of bar chart, pie chart, and line charts
b. Interpreting data in the form of bar chart, circle, and line

The supporting data students are given a questionnaire that provides information about student difficulties in learning descriptive statistics. In addition to providing questionnaires, before performing the tests of reasoning and statistical communication skills, researchers conduct interviews with students to obtain more information about students' difficulties in studying statistical materials. The observed data collected from questionnaires, misconception tests, and students' statistical reasoning tests were analyzed through the following steps:
1) Perform tabulation of data about learning difficulties faced by students in statistical materials.
2) Classify the kinds of difficulties students’ experiences.
3) Classify reasoning ability and statistical communication.
4) Present statistically descriptive tests of reasoning and statistical communication skills.

4. Result and Discussion
Preliminary analysis of the results of observations from questionnaires and interviews of students who experienced difficulties they experienced during the learning process are:
a) Experiencing difficulties in recognizing and classifying data types and displaying them on graphs or tables.
b) Less understanding of how to file allegations.
c) Still experiencing confusion in drawing conclusions, compiling evidence, giving reasons or evidence against the truth of the solution,
d) Poorly understood correctly draw conclusions from statements,
e) Understandably in examining the validity of an argument,
f) Less know how to find patterns or properties of mathematical phenomena to make generalizations.

The result of the analysis of student difficulties will be used as a benchmark or reference for preparing teaching materials and selection of appropriate learning model in accordance with the characteristics of statistical materials based on constraints experienced by students in the learning process so as to improve students' reasoning and statistical communication.

Summary of observation data of students of mathematics education program for the variable of misconception test and student's statistic reasoning ability can be described in a table as follows:

| Variable                  | N  | Minimum | Maximum | Mean | Standard Deviation |
|---------------------------|----|---------|---------|------|--------------------|
| Reasoning and Communication Statistics Ability | 37 | 30      | 83      | 52, 8 | 8.5                |

The students' reasoning and communication statistic score has a very wide range, between the lowest score with the highest score of 53 with an average of 52.8 and standard deviation of 8.5 When using the standard score of 65 as the minimum score of the standard competency achievement of mathematics subjects in the class it will be seen that the mean value of the reasoning and statistical
tests is below the minimum competency standard. This value provides information that students' reasoning ability and statistical communication are still low.

The results of the analysis of difficulty in terms of the ability of statistical reasoning as shown in the following table:

| No | Misconception                             | Number of Students | Percentage (%) |
|----|-------------------------------------------|--------------------|----------------|
| 1. | Determine average value                   | 10                 | 27.02          |
| 2. | Determine median and mode value           | 8                  | 21.62          |
| 3. | Determine range value                     | 7                  | 18.92          |
| 4. | Drawing Graph                             | 5                  | 13.51          |
| 5. | Interpreting graph                        | 5                  | 13.51          |
| 6. | Irrelevant                                | 2                  | 5.04           |

Table 3 above shows that determine average value is 27.02%, determine median and mode value is 21.62%, determine range value is 18.92%, drawing graph is 13.51%, interpreting graph is 13.51%, and irrelevant is 5.04% it means students this means students still experience misconception in understanding variability.

Based on the results of the analysis, we can see that the percentage of misconception performed by the students as a whole is 20.82%. This percentage is much less than the percentage another error is 79.18%. Example of misconception conducted by students can be seen in the picture below.

Figure 1 above is the result of student work. Students do the wrong i.e. Process Skills Error. Based on the results of interviews with students, it is known that students are wrong in calculating the results.

Student wrong in calculation when \( \frac{20}{100} \) scaled down into \( \frac{1}{4} \). This is due to the inability of students within simplifying the fraction as well as the student's ignorance in completing problem on problem. For that in the required classroom learning is done repeatedly.

While the factors that can affect student learning difficulties in addition to internal factors of students that is 1) lack of early understanding of the material about statistics and 2) the motivation of students in following the teaching and learning process. While the external factors that affect student learning difficulties are: 1) the classroom environment is a) lack of facilities and infrastructure that can support students in understanding the subject matter, b) the lesson model applied less motivate the students to learn actively and creatively in understanding the material lessons, 3) the family environment is less supportive in creating a conducive atmosphere to provide opportunities for students to do home study, and 4) the community environment is an uncomfortable environment for students to perform activities that are wide-ranging insights. Students' learning difficulties in statistical
materials can be overcome by the way teachers can maximize the teaching and learning process by applying learning models that can provide opportunities for students to participate actively.

5. Conclusion
The description of the difficulties in statistical material on the 8th-grade junior high school students based on the observation result has a percentage below the competency standard. Although the results of this study cannot be used as a tool to generalize the students' reasoning and statistical communication skills but the authors provide the reference as one of the references in determining and defining the learning methods that will be applied so that student difficulties can be minimized and students' reasoning and communication statistics can be improved.

Acknowledgments
I would like to thank the Institute of Education Fund Management (LPDP) of the Ministry of Technology Research and Higher Education (Kemenristek Dikti) of the Republic of Indonesia who has given full support so that this paper can be realized.

References
[1] J. Garfield, “The challenge of developing statistical reasoning,” J. Stat. Educ., vol. 10, no. 3, pp. 58–69, 2002.
[2] D. Ben-Zvi and J. Garfield, “Statistical literacy, reasoning, and thinking: Goals, definitions, and challenges,” in The Challenge of Developing Statistical Literacy, Reasoning and Thinking, 2004, pp. 3–15.
[3] M. Lovett, “A Collaborative Convergence on Studying Reasoning Processes: A Case Study in Statistics.,” Cogn. Instr. Twenty-five Prog., Mahwah, NJ, 2001.
[4] D. Dasari, “Meningkatkan Kemampuan Penalaran Statistis Mahasiswa melalui Pembelajaran Model PACE.,” Disertasi SPS UPI, 2009.
[5] I. Maryati, “Peningkatan Kemampuan Penalaran Statistics Siswa Sekolah Menengah Pertama melalui Pembelajaran Kontekstual.” 2017.
[6] S. Parke, “Reasoning and Communicating in the Language of Statistics,” J. Stat. Educ., vol. 16, 2008.
[7] D. Rumsey, “Statistical Literacy as a Goal for Introductory Statistics Courses,” J. Stat. Educ., 2002.
[8] S. Wardhani, “Teknik Pengembangan Instrumen Penilaian Hasil belajar di SMP/MTs,” pp. 1–35, 2010.