J.Biol.Educ. 6 (3) 2017

Journal of Biology Education

http://journal.unnes.ac.id/sju/index.php/ujbe

# The Analysis of Students' Reasoning Skill in Palembang

**Safira Permata Dewi[1]✉, Nuryani Rustaman[1], Siti Sriyati[2]**

[1] Lecturer of Biology Education FKIP UNSRI
[2] Lecturer of Department of Biology Education UPI

***Info Article***

*History Article:*
*Received* : *October 2017*
*Accepted* : *December 2017*
*Published* : *January 2018*

*Keywords:*

*Reasoning, TIMSS 2011, Palembang City*

## Abstract

*This study aimed to get a picture of class VIII students' reasoning in A accredited schools in Palembang City through a survey. A number (n = 151) of grade VIII students were from four public and private schools. TIMSS Biology Problems used were the reasoning type both in the form of multiple choice and constructive response. The results showed that the reasoning of the eighth graders had a good performance and showed normal distribution. The achievement of students in solving the problem in multiple choice was better than the constructive response. Students found it difficult to address problems which demand designing an experiment. The findings of this research might be used to train students to develop their reasoning skills and improve the quality of Biology learning process in the classroom.*



✉ Correspondence:
Jl. Srijaya Negara, Palembang, Sumatera Selatan
E-mail: saphire2687@gmail.com

p-ISSN 2252-6579
e-ISSN 2540-833X

## INTRODUCTION

Thinking is a mental process that someone does by utilizing various information they have. This information will assist in the creation of definitions, identification of attributes, and other essential concepts. Processing a variety of simple information into more useful information cannot be separated from the role of the brain as the center of coordination of the human body. This information is not only derived from the learning process but also the events that are experienced by a person. All the senses that exist in humans have an important role in collecting various information for further processing.

Education has a critical role in the formation of one's thinking skills, one of which is the reasoning skills. The reasoning becomes urgent to be possessed by students as learners to be able to understand the various phenomena that occur in the vicinity. Habituation in reasoning should be taught as early as possible to provide supplies to the students as they blend with the community and the environment.

Various ways can be done to help develop students reasoning. The training process can be done in the learning process. In addition, the provision of questions that are oriented to develop the ability of reasoning can be mad. Reasoning problems are one of the problem areas developed by the IEA in every four-yearly evaluation that is known as TIMSS (Trends in International Mathematics and Science Study).

TIMSS is participated by 45 countries including Indonesia. The objectives of TIMSS are to provide important information to assist in monitoring and evaluating the achievements of mathematics and science (Mullis, *et al*., 2009). The problems tested in TIMSS are questions that have been validated with different types of questions by emphasizing the content of science and math. One of the content and types of questions tested is Biology which needs reasoning.

Based on the results of the implementation of TIMSS carried out it is known that the achievement of Indonesian students of class VIII is not encouraging. According to Rustaman (2009), the low achievement of eighth graders in solving the TIMSS Biology question indicates that science learning (1) has not given opportunity to the students to gain knowledge about the tools, methods and procedures of science; (2) have not exercised the ability to apply such knowledge to conduct scientific inquiry; and (3) has not provided an opportunity for students to use scientific understanding so that students can provide evidence-based explanations. The results of this TIMSS implementation also illustrates the reasoning ability of VIII students in Indonesia is still very low. According to Rustaman (2009), the low level of Indonesian students 'reasoning could be caused by the Indonesian students' reading strategy which is still so poor that the level of reasoning is still linear and fragmented.

Research conducted by Agasi*, et al*. (2014) indicated that grade VIII students still had difficulty in resolving the TIMSS type of reasoning because students were not accustomed to working on these questions. This was caused by the lack of sensitivity of students analyzing all the information contained in the problem. This contrasts with research conducted by Hazlita *et al*. (2014) which stated that the students of class VIII had been able to make good mathematical reasoning in the form of explanation with the help of the model and draw conclusions.

This study aime to explore a clear picture of the reasoning of the students of class VIII in Palembang through the provision of Biology TIMSS 2011. The findings of this study could serve as a foothold to analyze students' difficulties in reasoning to find the best solution in the development of a more meaningful learning experience. In addition, the results of this study are expected to be used as a reference to develop a variety of evaluation tools to measure students' reasoning abilities.

## RESEARCH METHOD

### Methods and Research Subjects

This research was a survey. In this study, there was no special treatment. The population of this study was the students of grade VIII junior high school from "A" accredited schools, both of state and private schools. The number of students sampled was 151 students, coming from 4 schools. Selection of this school was by the random technique.

### Research Instruments

The data collection of this research was done by giving a test to the students. The test instrument used consisted of questions of reasoning from the biology of TIMSS 2011. The reasoning was given to get an idea of how the students of grade VIII SMP in Palembang in solving the problem.

The question of reasoning from the Biology TIMSS 2011 issue is a matter published by the IEA. Furthermore, the problem was translated into Bahasa Indonesia. Before this question was used to be tested legibility on 42 students of class VIII in Palembang. The tested questions were seven questions consisting of three multiple-choice questions and four constructed-response questions (the lattice of the questions is given in Table 1). On multiple choice, five alternative answer options were available to assist the student in solving the problem.

**Table 1** The framework of the domain of reasoning TIMSS 2011

| Problems No. | Code | Topics/Material | Problem Number | Problem form | Cognitive Domain | Score |
|---|---|---|---|---|---|---|
| 1. | S052030 | Ecosystem/water transport in plants | 1 | Multiple Choice | Reasoning | 1 |
| 2. | S052091 | Ecosystem/air pollution | 4 | Constructed Response | Reasoning | 1 |
| 3. | S042304 | Human life process/circulation system | 2 | Multiple Choice | Reasoning | 1 |
| 4. | S032665 | Ecosystem/population density | 6 | Constructed Response | Reasoning | 2 |
| 5. | S042022 | Cells and their functions/factors of plant photosynthesis | 5 | Constructed Response | Reasoning | 1 |
| 6. | S042297 | Heredity/inheritance of nature and reproduction | 7 | Constructed Response | Reasoning | 2 |
| 7. | S032315 | Ecosystem/relationship between ecosystem components | 3 | Multiple Choice | Reasoning | 1 |

### Data analysis

The results of students' achievement of grade VIII SMP in Palembang in solving the TIMSS Biology 2011 problem domain of reasoning was obtained from the total score of student test score (maximum score 100). Guidelines for scoring each question was based on the provisions contained in the Biology TIMSS 2011. The results of all students were then ranked according to the score of achievement score of the highest score to the lowest score. Scores that had been sorted then processed so that the data obtained in the form of tabulation of class intervals. While many classes of 3 consisting of low, medium, and high achievements to facilitate further data analysis.

The length (p) of the class was determined by the formula:

$$p = \frac{Distance}{Total\ of\ classes}$$ (Sudjana, 2005)

## RESULTS AND DISCUSSION

The implementation of TIMSS is used as a reflection tool of various participating countries about the achievement of its students among other participating countries and knowing how far is the implementation of junior high school curriculum in the country. One way to know the effectiveness of curriculum implementation is to know the level of student achievement in solving the given problem. Biology is one of the content domains tested. The emphasis of the type of questions tested, among others, is the reasoning.

The reasoning abilities need to be developed to form habits in the learning process. Many things can be done to develop students' reasoning abilities, including the development of learning activities that lead to this competence that ends with the provision of evaluation that requires students to use reasoning skills. The development of learning process based on reasoning will certainly help students to hone their skills so that they can develop and can support learning outcomes. Musa & Usman (2014) explained that students who tend to use their reasoning abilities often perform better than students who rarely use this ability.

The TIMSS 2011 Biology Problems used in this study amount to seven questions, multiple choice and constructed-response. These questions were officially released by TIMSS in 2013. The achievements of grade VIII students in solving the TIMSS 2011 Biology reasoning problems are presented in the distribution table (Figure 1). Student outcomes were then categorized into three groups, namely low, medium and high category.

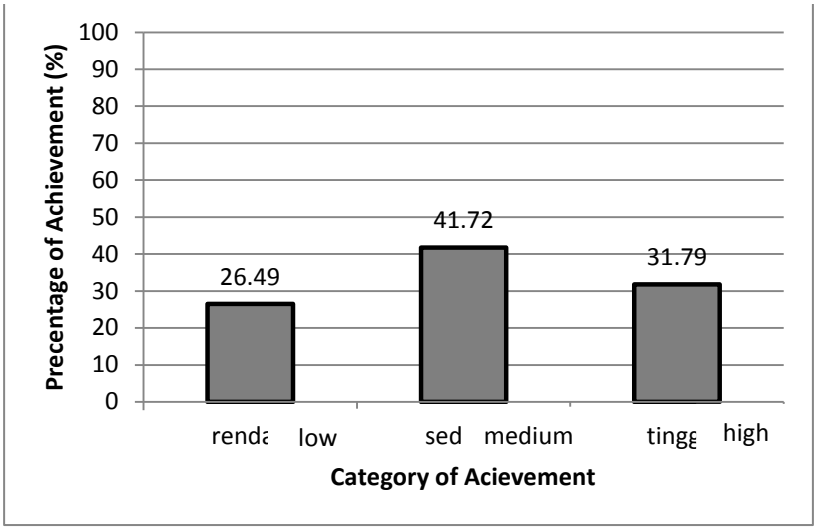



**Figure 1** Percentage of Student Achievement Level

Figure 1. shows that students' ability in the normal distribution range. That is the ability of junior high school students in Palembang quite well. The high category also has a better percentage of performance than the low category. Based on a study conducted by Nnorom (2013), students with high reasoning rates showed excellent outcomes compared to low-grade students regardless of the student's gender. According to Bhat (2016), teachers can help develop students' reasoning by assigning

various tasks and using questions that can encourage students to conduct investigations so that students can improve their formal reasoning skills.

The achievements shown in this study are inseparable from the character of the samples used. Students who become samples were students who come from "A" accredited schools. In general, "A" accredited schools had better student input than other accredited schools. Learning and Supporting learning facilities and infrastructure have certain value standards. The focus of the assessment on the determination of school accreditation is the standard of content, process, competency of graduates, educators and education personnel, facilities and infrastructure, management, financing, and assessment (National Accreditation Board School / Madrasah, 2017).

When viewed from the age of students while taking this test, ideally they have a level of intelligence in the formal phase , with age between 13-14 years (Valadines, 1997). Based on the theory of cognitive development, in this phase, a child has been able to think scientifically, theoretically, able to express opinions, test the hypothesis and be able to solve problems logically by involving various concepts related (Nurgiantoro, 2005). The students' reasoning and abstracting abilities are at the level of formal development. This can be seen from the tendency of heuristic, empirical, and rational use in decision making. Valanides (1997) also explains that someone who has reached the formal stage will be better at solving the reasoning problems compared to other stages of development. The results of research conducted by Musa & Usman (2014) explain that students who are in the formal phase will show positive results on learning achievement and have a good ability in predicting.

The form of questions tested affects student achievement in solving the given problem. The results of this study indicate that students tend to be able to solve the problem of multiple choice better than the problem of constructive respond. Table 6 shows that all multiple-choice questions can be completed well by more than 50% of students. According to Dewi (2014), an choice of answers that have been available on the problem of multiple choice makes it easier for students in solving the given problem. According to Sangwin & Jones (2017), students who can solve multiple choice problems easily may experience constraints when given constructive responses. This is because students tend to pursue practical avenues by choosing one of the more familiar or intuitive and rational choices of answers (Sangwin & Jones, 2017., Dewi, 2014).

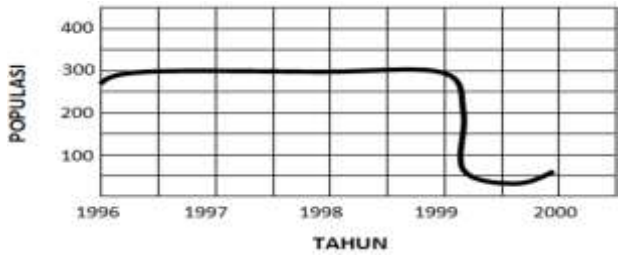
**Table 2** Number of Students Based on Each Outcome

| Problem Types of Problems | Problem Number | Score | The Number of Students |
|---|---|---|---|
| Multiple Choice | 1 | 1 | 76 |
| | | 0 | 75 |
| | 2 | 1 | 104 |
| | | 0 | 47 |
| | 3* | 1 | 118 |
| | | 0 | 33 |
| Constructive Respons | 4 | 1 | 117 |
| | | 0 | 34 |
| | 5 | 1 | 100 |
| | | 0 | 51 |
| | 6 | 2 | 28 |
| | | 1 | 51 |
| | | 0 | 72 |
| | 7* | 2 | 45 |
| | | 1 | 3 |
| | | 0 | 103 |

The results of the research have shown that the problem of multiple choice type in item no. 3 is a question that most students can answer. A total of 118 out of 151 students can solve this problem well. Here is a snippet of the problem no. 3 which discusses Ecosystem / relationship between ecosystem components.

**Problem No. 3**

Look at the picture below!




Source: S032315

The chart above shows the number of deer in some areas over a period of time. Which of the following statements might be the cause of the change in deer population between 1999 and 2000?

a. Global warming
b. The absence of predators
c. Depletion of the ozone layer
d. Forest fires that reduce food supplies

In this case, reasoning ability is quite high. This is because students are not only required to read the graph but also can find the relationship between the variables available in it. To be able to solve this problem, students are required to understand the chart before reasoning and then find the right conclusions. The number of students who can solve this problem is something that is a very good achievement considering understanding the graph requires a comprehensive ability of the various variables that exist. According to Rustaman (2009) the problem that requires students to understand the graph is included in a very complex task because it requires students to understand the variables that exist on the graph. This is certainly supported by students' intelligence capabilities that have been in the formal phase so that the process of application of concepts and abstractions can be done well. According to Tebabal & Kahssay (2011), students' communication skills are influenced by how the learning process takes place in school. More student-centered learning leads the student to have better communication skills than traditional students. This is because students have more opportunity to understand the concept of science well.

The ability of students in solving this problem is not only caused by the assistance provided through the graph but also the availability of alternative answers which makes it easier for students to solve this problem. Alternative answers available can help students who have difficulty recalling the concepts they have learned by analyzing each alternative answer.

The concept tested was very close to the students, that is the concept. This concept has been familiar to students from elementary school level. Various experiments are often done by students to be able to understand this concept well. An empirical learning experience that has been experienced by students is certainly very helpful in solving this problem. Learning activities through lab work to support students' cognitive development well (Hart, *et al.*, 2000). Furthermore, Hart, *et al*. (2000) also added an understanding of concepts and activities based on hands-on learning to facilitate students in shaping the overall conclusions of the learning experience.

The achievement of students in solving the problem of No.5 is very contrary to the problem no. 7. Problem No. 7 is the question that least students can answer correctly. Here is a snippet of the question.

**Problem Number7**

Dini and Ayu are studying plants. They studied the characteristics of plants such as fruit weight and fruit color. They observed green peppers and red peppers.

Source:

http://www.thevegetarianexperience.co.uk

Source:

http://www.stylecraze.com

Dini thinks, from initial look, both are different types of peppers, because they have different colours. Ayu thinks that both are the same two types of peppers, red peppers turn red because they took longer to be picked from the plants and therefore become more mature. Explain the possible investigative plan to decide whether it is Dini or Ayu whose statements are in line with reality?

Problem No. 7 is a matter that not only demands students to design the right experiment to prove the opinion of who is right. The results of students' answers tend not to answer the problem. Students are only inclined to give an argument about who has the right opinion without giving a trial plan to prove it. This certainly illustrates that the ability of students in designing the experiment is still very low. According to Dewi (2014), the low achievement is due to the students not used to being trained to experiment and design their own experiments. As students are continuously trained to design experiments, learning has taught students to increase their confidence in working independently (Robert, 2001). In addition, designing experiments is essential for training students in objectively evaluating past experiments and encouraging students to transcend all the limitations they have had on both conceptual and other supporting knowledge (Shi *et al.*, 2011).

Research conducted by Saputra, *et al*. (2012) in the academic year 2011/2012 shows that the ability of junior high students in designing experiments is very low. This can be seen from the 17 aspects of concern in his research. The tendency to increase the ability to design the experiment increase after passing through four learning cycles. This proves that students' ability in designing experiments can be honed as long as they are getting used to and given trust.

When viewed from the national curriculum, the new genetics will be studied by students in class IX, considering the target of TIMSS participants and the sample in this study are the students of grade VIII SMP. The difficulty of solving this problem is also caused by the lack of early knowledge

of students about the genetic concepts it has. This is in line with research conducted by Kilic, *et. al* (2016). The results of this study indicate differences in outcomes on first-tier and both-tier questions. According to Kilic, et al. (2016) students do have difficulties in understanding the basic concepts of genetics because of limited knowledge.

This research shows that the reasoning ability of VIII students in Palembang City through TIMSS 2011 is good enough. Some of the problems encountered in solving these problems have also been found, such as the lack of student learning experience to train their own experimental design habits as a form of investigation to solve the problem. All the difficulties found by students could be improved in the future by starting to train students to get used to the problems through the process of reasoning. This reasoning skill could be developed through meaningful learning and focuses all teaching and learning activities for students as learning centers and teachers as facilitators. Teachers should also facilitate students to design their own experiments so that students' communication skills can develop better and have increased confidence.

This study was able to record only four schools of the entire population. This was because the time and access to the schools were very limited. The samples taken were only one to two classes from the sample schools.

## CONCLUSION

In general, students' reasoning ability is very good in solving the TIMSS problems given. This can be seen from the percentage of students who reach 86% are in the medium and high category. This cannot be separated from students' intelligence ability which on average has been in the formal phase. In this phase students have a good level of abstract concept so they can understand the concept and graphics well. Students have no difficulty in understanding the graph to use as a basis for reasoning and inferring. However, students have difficulty in designing experiments. This is because the habit of designing experiments has not been widely applied by teachers in daily learning activities.

## REFERENCES

Agasi, G.R., &Rudhito, M.A. (2014). Kemampuan siswa kelas VIII dalam menyelesaikan soal-soal TIMSS tipepenalaran. *Prosiding*. Seminar Sains dan Pendidikan Sains IX, Fakultas Sains dan Matematika, UKSW. 5(1): 879-888.

Bhat, M. A. (2016). The predictive power of reasoning ability on academic achievement. *International Journal of Learning, Teaching and Educational Research*. 15(1):79-88.

Hart, C., Mulhall, P., Loughran, J., &Gunstone, R.. (2000). What is the purpose of this experiment? Or can students learn something from doing experiment? *Journal of Research in Science Teaching, 37* (7):655-675.

Hazlita, S., Zulkardi., & Darmowijoyo. (2014). Pengembangan Soal penalaran model TIMSS konteks Sumatera Selatan di Kelas IX SMP. *Jurnal Kreano*. 5(2): 170-179

Kilic, D., Taber, K. S., & Winterbottom, M.(2016). A Cross-nation study of students' understanding of genetic concepts : implication from similarities and differences in England and Turkey. *Educational Research International*. 2016:1-14.

Musa, M., & Usman, I. H. (2014). Effects of Piagetian formal operations on mathematics performance of senior secondary students in Kaduna State, Nigeria. *British Journal of Education*. 2 (2):62-69.

Mullis, I., Martin, M.O., Ruddock, G.J., O'Sullivan, C.Y., & Preuschoff, C. (2009). *TIMSS 2011 assessment framework*. [Online]. Tersedia di: http://timss.bc.edu/. Diakses 30 Juli 2017.

Nurgiantoro, B. (2005). Tahapan perkembangan anak dan pemilihan bacaan sastra anak. *Cakrawala Pendidikan 24* (2): 197-216.

Nnorom, N.R. (2013). The effect of reasoning skills on students achievement in biology in Anambra State. *International Journal of Scientific & Engineering Research*. 4:2102-2104.

Robert, L. M. (2001). Developing experimental design and troubleshooting skills in an advanced biochemistry lab. *Biochemistry and Molecular Biology Education*. 29(2001):10-15.

Rustaman, N.Y. (2009). *Analisis konten dan capaian sains siswa Indonesia dalam TIMSS (Trends in International Mathematics and Science Study) tahun 1999, 2003, dan 2007*. Jakarta: Badan Penelitian Pengembangan Departemen Pendidikan Nasional.

Sangwin, C. J., & Jones, I. 2017. Asymmetry in student achievement on multiple-choice and constructed-response items in reversible mathematics processes. *Education Study Mathematics*. 2017 (94):205-222.

Saputra, A., Widoretno, S., & Santosa, S. (2012). Peningkatan keterampilan merancang eksperimen siswa melalui penerapan strategi *guided inquiry* di SMP Negeri 5 Surakarta Kelas VIII F Tahun Pelajaran 2011/2012. *Prosiding*. Biologi, Sains, Lingkungan, dan Pembelajarannya dalam Upaya Peningkatan Daya Saing Bangsa.

Shi, J., Power, J.M., &Klmkowsky, M. W. (2011). Revealing student thinking about experimental design and the role of control experiments. *International Journal for Scholarship of Teaching and Learning*. Vol. 5(2).

Sudjana. (2005). *Metode statistika*. Bandung: Tarsito

Tebabal, A. & Kahssay, G. (2011). The effects of student centred approach in improving students' graphical interpretation skills and conceptual understanding of kinematical motion. *Latin American Journal Physic Education*. 5(2):374-381.

Valadines, N. (1997). Formal reasoning abilities and school achievement. *Studies in Educational Evaluation*, *23* (2), page. 169-185.