LEVEL OF SCIENTIFIC ARGUMENTATION ABILITY OF STUDENTS IN BIOLOGY LEARNING

Lidya Hasmaningsih, Karnan*, and Baiq Sri Handayani
Biology Education Department, Faculty of Teacher Training and Education University of Mataram, Mataram, Indonesia
*Email: karnan.ikan@unram.ac.id

Abstract: Scientific argumentation is one of the skills needed in the 21st century. The purpose of this study was to analyze the level of scientific argumentation ability of students in class XI biology learning using plant tissue material at SMAN 1 Labuhan Haji. The research method used is descriptive qualitative with research instruments in the form of scientific argumentation ability tests, questionnaires, and interviews. The population in this study amounted to 133 people. The sample was selected using the census technique so that it used a saturated sample or all members of the population, namely class XI MIPA 1, XI MIPA 2, XI MIPA 3, and XI MIPA 4. The results showed that the student's written and oral scientific argumentation skills were still low and needed to be empowered again. Students' written scientific argumentation ability is at level 2 with a percentage of 74.9%, and oral scientific argumentation is at level 2 with a percentage of 73%.

INTRODUCTION

Education has a big role in its contribution to improving the quality of human resources [1]. The vision of Indonesian education is the formation of a golden generation in 2045. There are challenges from globalization and the industrial revolution 4.0 that must be faced by mastering 21st-century skills. Students are trained to have strategies in 4 things, namely skills for living in the world, tools of working, ways of thinking, and ways of working in which collaboration and communication skills need to be demonstrated [2].

Wagner in 2010, stated that students need to master effective ways of communicating, both orally and in writing [3]. The way someone communicates an idea can show reasoning abilities [4]. Based on 2015 PISA (Program for International Student Assessment) data, students are still unable to solve questions that require reasoning; the scientific literacy rating of Indonesian students is still low and ranks 64th out of 72 participating countries with a score of 403 below the score that has been set by the OECD Institute [5]. These communication skills and reasoning abilities are packaged in an ability called scientific argumentation [6].

The ability to make scientific arguments is a charge in critical thinking indicators [7]. In 2012, Puig and Jimenez-Aleixandre said that supporting the development of critical thinking is a form of argumentation contribution to educational goals [8]. Critical thinking skills have been widely studied, including in the West Nusa Tenggara region, which is generally still found in the low category [9]. Scientific arguments, as one of the five indicators in it can be one of the reasons that contribute to the difficulties of students in perfecting critical thinking.

There are at least 3 reasons that scientific argumentation is so important. First, the birth of knowledge cannot be separated from the scientific arguments formulated by scientists. Second, its use in society is also very much needed as a solution when finding scientific debates. Third, scientific argumentation is a need in learning to increase understanding [10].

The results of observations made by researchers during the School Field Introduction activity at SMAN 1 Labuhan Haji in September-November 2021 revealed that students had a low interest in learning biology so that based on the information of the biology teacher concerned, this was overcome by providing Participant Worksheets. Educate to improve literacy skills and be actively involved in finding answers as a form of participation. It's just that this method cannot guide students to turn the classroom atmosphere into an interactive one. When asked a direct question, only one or two people raised their hand and made a comment.

The forms of statements, opinions, and comments made by students during the learning process can actually be measured using Toulmin's Argumentation Pattern (TAP) assessment form [11]. Several studies have been conducted on the ability to argue in the West Nusa Tenggara region, such as that conducted by Jufri et al. (2016), 95% of students who are prospective teachers of Mathematics and Natural Sciences at Mataram University have low ability [12]. The results of Anshori's (2021) research also inform that students in solving permutations and combinations have been able to meet four indicators of argumentation ability [13]. The first study used the Classroom Test of Scientific Reasoning (CTSR), while the second used Toulmin's Argumentation Pattern (TAP) assessment form, but there was no

information on the level of students' scientific argumentation.

Based on the studies that have been carried out, the researchers know that information regarding the analysis of the level of scientific argumentation skills of students in class XI biology learning has contributed to the world of education so that it is relevant for research.

RESEARCH METHODS

This research was conducted at SMAN 1 Labuhan Haji, East Lombok, West Nusa Tenggara. This study was carried out in the odd semester of the 2021/2022 academic year in July-August 2022. The type of research used was descriptive qualitative. Determination of the sample was selected by the census technique. The samples used were all members of the population (saturated samples), namely class XI MIPA 1, XI MIPA 2, XI MIPA 3, and XI MIPA 4, totaling 133 people. The data collection technique used a scientific argumentation ability test, a questionnaire with a Likert scale of 1-5, and interviews with teachers and students. Written scientific argumentation data were taken using an essay test totaling three questions and then analyzed using a modified Herlanti (2014) assessment framework sourced from Inch 2006 and Dawson & Venville 2009, then differentiated based on appropriate and incorrect quality. Transcripts of student conversations obtained during the question and answer session using a voice recorder for two meetings with the number head together learning model were analyzed based on the assessment framework of Osborne et al. (2005) as oral scientific argumentation data [14]. The percentage level of scientific argumentation ability can be identified by the formula [15] :

$$= \text{number of student at level/total} \times 100\%$$

Test the validity of the data using a model from Sugiyono (2014), which includes a credibility test in the form of a member check [16]. The data analysis technique was adapted from Umrati & Wijaya (2020), which consisted of data reduction, data presentation, and conclusion drawing [17].

RESULTS AND DISCUSSION
Written Scientific Argument Ability

Written scientific argumentation skills can be grouped into five levels, with level 1 being the lowest level and level 5 being the highest level. The more components of written scientific argumentation indicators listed in students' answers, the higher their written scientific argumentation abilities. The data on the students' written scientific argumentation ability test results can be seen in the figure below:
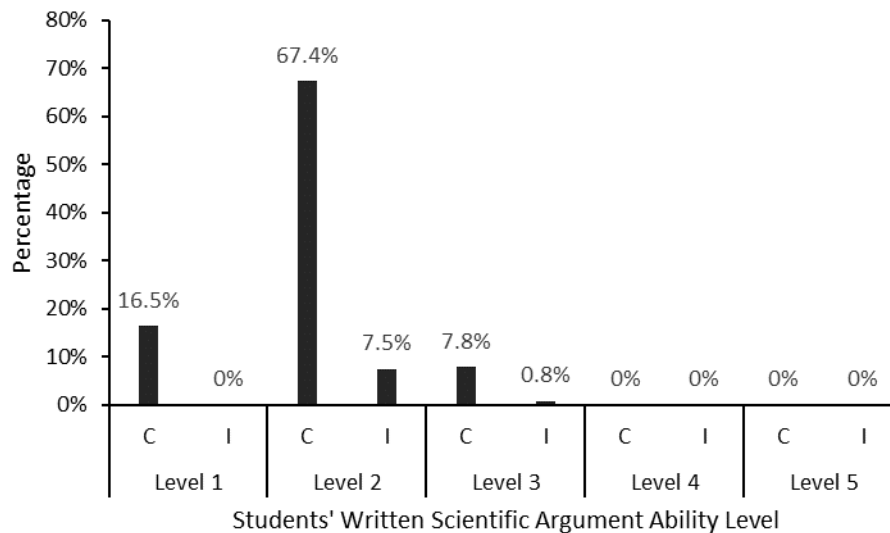

Figure 1. Percentage of Students' Written Scientific Argument Ability Level

Based on Figure 1. the percentage of written scientific argumentation skills of students is at level 2, with the quality of correct answers 67.4% and 7.5% incorrect so that the total percentage becomes 74.9%. The next student's ability at most is at level 1, with a percentage of 16.5%. Only 8.6% of students can reach level 3, and 0% at levels 4 and 5.

The student's written scientific argumentation abilities, which are mostly at level 2, are caused by several factors. First, students already have an awareness of the importance of showing data to base the claims they make so that they are proven to be true and not fabricated. Second, it is easier for students to think of answering something based on facts that can be found in everyday life. This statement is supported

by the research of Hernita et al. (2021) that students try to use data in the form of facts that are around them even though they still often have difficulty separating between synchronous and inappropriate data to support the required answers [18]. The ability of written scientific argumentation at level 2 still needs to be developed again because it can still be said to be weak. The results of this study are in accordance with research conducted by Amalia et al. (2018) that the written scientific argumentation ability of students at the high school level is more at level 2 [19].

The written scientific argumentation ability of students who occupy the next high percentage position is level 1. Students occupy this level for several reasons. First, almost all students already have a basic understanding so that it can help them in deciding the form of claims to be made. Second, students will be more inclined not to include data or explanations if they conflict with the claim decisions that have been chosen. Third, some students admitted that it was better to choose one claim than to leave the answer blank even though they did not have the slightest knowledge about the questions asked because essay questions always gave points in each answer even though it was counted wrong. Students who have this reason rely more on instinct when answering. This is supported by the results of interviews which revealed that most of the students before coming to school did not equip themselves with learning unless they had assignments to do. Students also prefer multiple-choice questions rather than essays because it will be easier to decide on the answer without having to think about the reasons.

There are still very few students who have achieved written scientific argumentation at level 3, this is because learning in schools has not familiarized students with answering questions in the form of essays. Level 3 is a form of describing the ability of students when they have succeeded in providing answers with elements of claims, data and warrants which are defined as justifications that explain the relationship between data and claims. This is reinforced by the results of interviews between teachers and students. Questions that require explanations are very rarely issued in exams. Teachers give more tests using multiple choice. In fact, this is the first time they have done a written scientific argumentation test in this study. The ability of students up to level 3 at the high school level is actually sufficient but needs to be honed again. According to Piaget's theory of cognitive development, the age of class XI is said to have been able to do flexible reasoning because it is a new stage towards adult logic, although many have not been able to reach this level until they finish high school and enter college [20].

Level 4 and level 5 are the ability levels of students who have the lowest percentage because no one is able to reach this level. These two levels of argumentation are complex levels that are difficult to carry out [21]. Arguments at levels 4 and 5 belong to the high form of argumentation [22].

Osborne's 2014 research revealed that nine months is too short to develop argumentative skills. Based on information about students and the learning methods carried out while conducting research at the school concerned, the solution that can be done to train students' argumentation skills is through writing scientific papers such as writing papers and argumentative texts [23]. Through the practice of writing scientific papers, students are able to learn to make valid hypotheses and information because they are supported by reliable sources and references.

Oral Scientific Argumentation Ability

Oral scientific arguments based on the assessment framework used make refutation indicators as a benchmark for whether or not a person's level of oral scientific argumentation ability is high. The level of oral scientific argumentation starts from level 1 as the lowest level to level 5 as the highest level. The data on the students' oral scientific argumentation ability test results can be seen in the figure below:
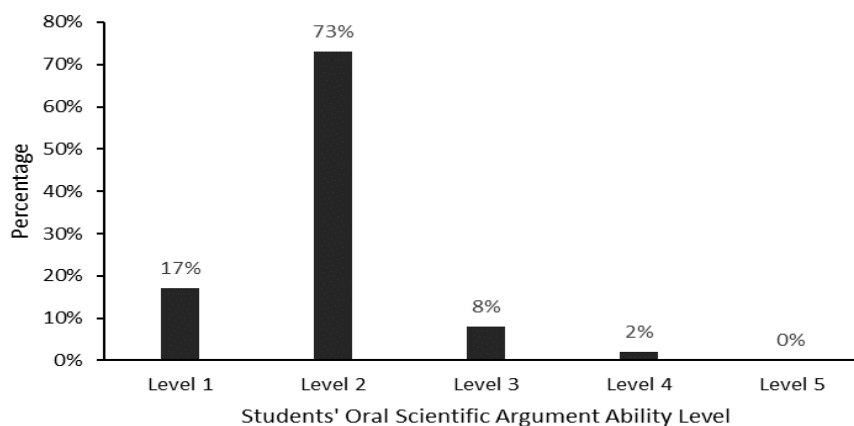

Figure 2. Percentage of Students' Oral Scientific Argument Ability Level

Based on Figure 2. it was found that the students' oral scientific argumentation skills were at level 2 with a percentage of 73%. The ability of the next most students is at level 1 with a percentage of 17%. There are only 8% of students who reach level 3, 2% at level 4, and 0% who are able to reach level 5.

The factors that cause most students to occupy level 2 in oral scientific argumentation sessions are not much different from those obtained during written scientific arguments. In addition, most of the students still rely on the answers stated when answering the written test. When conducting a question-and-answer session, the ability of students to express data or facts is easier to do. This is supported by student statements during discussions which more often use the words "ever found" or "ever seen" things related to the questions asked.

Some students are less able to rephrase their opinions in oral form because they are only able to provide answers at level 1 in the form of claims. Interview activities reveal information about students that they are afraid and not confident to argue so they often wait for other friends to present their arguments first and keep their own answers without raising their hands. This is supported by research conducted by Devi et al. (2018) that sometimes students answer the questions briefly asked not because they do not know the concept but students are more accustomed to being silent in class [24]. Second, students are able to process information from several of their friends so that the percentage of those who answer claims is lower than the previous written argumentation ability test. Some students tend to be weak when given a written test, but they can balance it during an argumentation session. They can develop information from several stimuli or keywords obtained into an argument that is almost correct and even true. This statement is in accordance with Nuryandi's research (2016) that the argumentation session places students in open dialogue to obtain information and then practice processing and change it in other forms which can finally be presented or expressed through their own version or way [25].

Based on the information obtained from the school, extracurricular activities turned out to affect the arguments of students in class. Students at level 3 are dominated by students who are active in extracurricular (organizational) activities. Students who take part in extracurricular activities are more daring to express their opinions than those who are not active in school activities. According to Tarigan & Rochintaniawati (2015), students will be trained to give arguments in oral and written form if they themselves are individuals who really like to ask questions and dare to argue even though the arguments made are wrong or wrong [26]. The

form of a refutation of level 3 arguments is also still relatively weak. Those who put forward arguments of their own accord are in line, students who participate in self-development through extracurricular activities usually take part in an activity on their own initiative without any element of coercion or under pressure [27]. Extracurricular greatly affect the communication skills and activeness of students at school [28].

There are students at SMAN 1 Labuhan Haji who have been able to reach level 4, although with a very small percentage. In addition, students who managed to reach this level when viewed from their learning achievement were students who were ranked in the top 3 in the class. At this level, students are able to compare their own arguments with those of other students so that if there are differences, they can be provoked to straighten out the arguments made by refuting each other and throwing back questions to find the correct answer [29].

Students have not been able to reach level 5, which means that students in the learning process have not been able to provide broad rebuttals. The actual discussion will be very interactive if found at this level. This is very reasonable because even college students may not necessarily be able to reach level 5.

Based on the discussion above, learning activities in class must be designed in advance with the right stimulus so that students have good scientific argumentation skills. At the time of the study, it was found that there were differences in responses between students and the clues given by the researcher during the argumentation session. This is always tried by researchers to be able to lead to the right answer or approach, but some students are not able to take advantage of this opportunity properly. In this oral argumentation session, the researcher also found out-of-context conversations that were not in accordance with the plant tissue material. There are students who put forward their answers jokingly so that it also has an impact on the learning activities of other students. On the other hand, in this study, students were more daring to express their opinions when compared to the information obtained from teachers in the field of study regarding the activeness of students during question-and-answer activities and daily discussions. Students consider the researcher as a tutor who is not far from the same age and is also a discussion partner so they are more daring to express their opinions than the teacher in the field of study concerned. Researchers also use the number head together learning model, which is able to help researchers get a large number of answers during the argumentation session.

CONCLUSION

Based on the results of research and discussion, it can be concluded that the level of written scientific argumentation ability at SMAN 1 Labuhan Haji is at level 2 with a percentage of 74.9% and students' oral scientific argumentation ability is at level 2 with a percentage of 73%.

REFERENCES

[1] Walid, A., Putra, E. P., & Asiyah, A. (2019). Pembelajaran Biologi Menggunakan Problem Solving Disertai Diagram Tree Untuk Memberdayakan Kemampuan Berpikir Logis Dan Kemampuan Menafsirkan Siswa. *IJIS Edu : Indonesian Journal of Integrated Science Education*, *1*(1),1-6.

[2] Rusyati, Permanasari, A., & Ardianto, D. (2019). Rekonstruksi Bahan Ajar Berbasis STEM untuk Meningkatkan Literasi Sains dan Teknologi Siswa pada Konsep Kemagnetan. *Journal of Science Education and Practice*, *2*(2), 10–22.

[3] Farawansyah, K. I., & Suyono. (2021). Pengembangan Lembar Penugasan Terstruktur pada Materi Laju Reaksi untuk Melatihkan Keterampilan Argumentasi. *Chemistry Education Practice*, *4*(2), 142–152.

[4] Noviantari, P. S. (2015). Penerapan Model Pembelajaran Learning Cycle "5E" Berbantuan LKS Terstruktur untuk Meningkatkan Kemampuan Penalaran dan Komunikasi Matematika. *Jurnal Santiaji Pendidikan*, *5*(2), 158–170.

[5] Yuliati, Y. (2017). Literasi Sains dalam Pembelajaran IPA. *Jurnal Cakrawala Pendas*, *3*(2), 21–28.

[6] Wibawa, R. A. P., Baskoro, A. P., & Marjono. (2018). Penerapan Problem Based Learning pada Materi Pencemaran Lingkungan untuk Meningkatkan Kemampuan Argumentasi Ilmiah Tertulis Siswa Kelas X MIPA. *Jurnal Biogenesis*, *14*(2), 29–36.

[7] Agnah, S. M., Rusdi, & Herlanti, Y. (2018). Penerapan Metode Peta Argumen terhadap Kemampuan Berpikir Kritis Peserta Didik SMA. *Biodidaktika: Jurnal Biologi Dan Pembelajarannya*, *13*(1), 57–66.

[8] Roviati, E., & Widodo, A. (2019). Kontribusi Argumentasi Ilmiah dalam Pengembangan Keterampilan Berpikir Kritis. *Jurnal Ilmiah Multi Sciences*, *11*(2), 56–66.

[9] Iftitahurrahimah, I., Andayani, Y., & Al Idrus, S. W. (2020). Pengaruh model problem based learning (pbl) terhadap kemampuan komunikasi siswa materi pokok larutan elektrolit dan non-elektrolit. *Jurnal Pijar Mipa*, *15*(1), 7-12.

[10] Siska, Triani, W., Yunita, Maryuningsih, Y., & Ubaidillah, M. (2020). Penerapan Pembelajaran Berbasis Socio Scientific Issues Untuk Meningkatkan Kemampuan Argumentasi Ilmiah. *Edu Sains Jurnal Pendidikan Sains & Matematika*, *8*(1), 22–32.

[11] Probosari, R. M., Ramli, M., Harlita, Indrowati, M., & Sajidan. (2016). Profil Keterampilan Argumentasi Ilmiah Mahasiswa Pendidikan Biologi FKIP UNS pada Mata Kuliah Anatomi Tumbuhan. *Bioedukasi: Jurnal Pendidikan Biologi*, *9*(1), 29–33.

[12] Jufri, A. W., Setiadi, D., & Sriptami. (2016). Scientific Reasoning Ability of Prospective Student Teacher in The Excellence Program of Mathematics and Science Teacher Education in University of Mataram. *Jurnal Pendidikan IPA Indonesia*, *5*(1), 69–74.

[13] Anshori, H. (2021). *Analisis Pola Argumentasi Siswa dalam Menyelesaikan Soal Permutasi dan Kombinasi*. (Skripsi, Universitas Islam Negeri Mataram, Indonesia).

[14] Herlanti, Y. (2014). *Blogquest +: Pemanfaatan Media Sosial pada Pembelajaran Sains Berbasis Isu Soiosaintifik untuk Mengembangkan Keterampilan Berargumentasi dan Literasi Sains*. Bandung: Universitas Pendidikan Indonesia.

[15] Mulyadi, S. R., Patty, E. N. S., Ama, H. D., & Anggraeni, D. M. (2019). *Buku Matrikulasi Matematika Dasar untuk Tingkat Perguruan Tinggi*. Uwais Inspirasi Indonesia.

[16] Pranowo, G. (2021). *Monograf Pengelolaan Pembelajaran Mata Pelajaran Produktif Kelas Nautika*. Klaten: Penerbit Lakeisha.

[17] Umrati, & Wijaya, H. (2020). *Analisis Data Kualitatif Teori Konsep dalam Penelitian Pendidikan*. Makassar: Sekolah Tinggi Theologia Jaffray.

[18] Hernita, A., Handayanto, S. K., & Supriana, E. (2021). Eksplorasi Scientific Explanation Berdasarkan Tingkat Kemampuan Peserta Didik. *Jurnal Pendidikan: Teori, Penelitian, Dan Pengembangan*, *6*(5), 687–691.

[19] Amalia, N. F., Riandi, Widodo, A., & Rochiantaniawati. (2018). Kompleksitas Argumentasi Berbasis Isu Sosiosaintifik pada Jenjang SD, SMP, dan SMA. *Indonesian Journal of Biology Education*, *1*(1), 29–32.

[20] Susanti, A., Sajidan, & Sugiyarto. (2014). Pembelajaran Biologi Menggunakan Inquiry Training Models dengan Vee Diagram dan KWL Chart Ditinjau dari Keterampilan Berpikir Kritis dan Kemampuan Penalaran Formal. *Jurnal Inkuiri*, *3*(1), 75–84.

[21] Rahayu, Y., Suhendar, & Ratnasari, J. (2020). Keterampilan Argumentasi Siswa pada Materi Sistem Gerak SMA Negeri Kabupaten Sukabumi-Indonesia. *Biodik: Jurnal Ilmiah Pendidikan Biologi*, *6*(3), 312–318.

[22] Noer, H. A., Setiono, & Pauzi, R. Y. (2020). Profil Kemampuan Argumentasi Siswa SMP

pada Materi Sistem Pernapasan. *Jurnal Pelita Pendidikan*, *8*(2), 138–144.

[23] Junaidi, E., & Nasirin, K. (2021). Hubungan Hasil Belajar dengan Positive Interdependence Pada Implementasi Model Peer-Assisted Learning Strategies. *Jurnal Pijar Mipa*, *16*(3), 340-344.

[24] Humairoh, S., & Yonata, B. (2022). Implementation of guided inquiry learning model to train students' critical thinking skills on reaction rate topic. *Jurnal Pijar Mipa*, *17*(2), 136-142.

[25] Nuryandi, A. (2016). *Penerapan Dialogical Argumentation Instructional Model (DAIM) untuk Meningkatkan Pemahaman dan Kemampuan Argumentasi Siswa SMA pada Materi Listrik Statik*. (Tesis, Universitas Pendidikan Indonesia, Indonesia).

[26] Tarigan, E. A., & Rochintaniawati, D. (2015). Pengaruh Metode Praktikum Berbasis PBL Terhadap Kemampuan Argumentasi Tertulis Siswa pada Materi Interaksi Mahluk Hidup dengan Lingkungannya. *Edusains*, *7*(2), 135–142.

[27] Meria, A. (2018). Ekstrakurikuler dalam Mengembangkan Diri Peserta Didik di Lembaga Pendidikan. *Turast: Jurnal Penelitian Dan Pengabdian*, *6*(2), 177–188.

[28] Irmawati, H., Sulistyaningrum, C. D., & Subarno, A. (2020). Pengaruh Partisipasi Siswa dalam Ekstrakurikuler dan Keaktifan Belajar terhadap Kemampuan Komunikasi Siswa Kelas X OTKP SMK Negeri 6 Surakarta Tahun Ajaran 2019/2020. *Jurnal Informasi Dan Komunikasi Administrasi Perkantoran*, *4*(3), 109–116.

[29] Nuryandi, A., & Rusdiana, D. (2015). Penerapan Dialogical Argumentation Instructional Model (DAIM) untuk Meningkatkan Pemahaman dan Kemampuan Argumentasi Siswa SMA pada Materi Listrik Statik. *Jurnal Penelitian Pendidikan UPI*, *15*(3), 76–83.