

THE EFFECTIVENESS OF STUDENTS WORKSHEET BASED ON INQUIRY BY DESIGN ARGUMENTATION ACTIVITY IN BRYOPHYTE

Bil Bila Ade Laila

Biology Education, Faculty of Mathematics and Natural Science
Universitas Negeri Surabaya
E-mail : billaila@mhs.unesa.ac.id

Rinie Pratiwi Puspitawati

Biology Education, Faculty of Mathematics and Natural Science
Universitas Negeri Surabaya
E-mail : riniepratiwi@unesa.ac.id

Abstract

This research was aimed to describe the validity and the effectiveness of student worksheet based on inquiry by design argumentation activity in Bryophyte. The student worksheet was developed by Fenrich cycle (1997). The research stage was begun with the curriculum, concept, indicator and student analysis. Design and development worksheet were done in Biology Department, Faculty of Mathematics and Natural Science, Universitas Negeri Surabaya. The student worksheet was implemented by the twelve 10th grade student of SMA Negeri 18 Surabaya. The data of student worksheet validity obtained from the validation by validators. The data of worksheet effectiveness obtained from argumentation test by students. Based on validity result by the validators, showed that the student worksheet was classified as very valid with average score of 3.97. Based on effectiveness result, showed that students was classified as good argumentation with score 75% and 60.19% students can made a claim with data so the student worksheet was able to implemented in the learning activity.

Keywords : student worksheet, inquiry, bryophyte, argumentation ability

INTRODUCTION

2013 Curriculum emphasizes that learning must be student-centered. Students must be active in finding the concept of learning observed with discovery or observation. Inquiry learning is one of the learning models that can be used to apply learning in accordance with the 2013 Curriculum. Inquiry learning is meaningful learning through discovery learning. Inquiry learning was learning that teaches the process of science and produces products by student (Harlen, 2014). Discovery activities were characteristic of science learning (Bricker & Bell, 2008). Science learning was a way to gain knowledge through the study of natural phenomena and linking them to the results of knowledge then communicating the results (Roshayanti, 2012). Communication was one of the demands of the 2013 curriculum and is related to the demands of the 21st century (BSNP, 2010).

Communication skills through oral and written was a demand that must be owned by someone to express their idea (Arifin, 2000). Learners can be trained to use scientific language or scientific communication by providing opportunities in scientific discourse such as developing hypotheses and arguments (Lemke, 1990). Inch, et al., (2009) stated that argumentation was an ability possessed by individuals in making decisions, maintaining decisions, and influencing others with the data obtained

accompanied by rationality. So, argumentation is one step to practice communication skills.

Argumentation ability is an important thing that must be possessed by students to be able to provide the scientific reasons for the phenomenon being studied and able to communicate it like a scientist. The suitable KDs to train argumentation ability in the 2013 Curriculum is KD 3.8 and KD 4.8 in Biology class X high school pairs. KD 3.8 demands the students to be trained to have critical and creative skills by characterizing and comparing these characteristics. KD 4.8 demands the students to be trained to have communication skills and collaborate with presenting the results of observations and analyzing fenetic relationships.

These KD demands, can be achieved if the learning process is carried out through various activities that guide students to be active in learning by finding out directly what is learned. The statement based on the research of Hendratmoko (2016) that students must be active in taking data, processing data, and making claims and then communicating with the appropriate theory and giving refutation of inappropriate opinions. Along with these activities, the learning model that can be applied to support the ability of argumentation is inquiry learning. The inquiry learning based on observations will strengthen the claims prepared by students (Rahmad, 2018). In

addition, inquiry learning collaborated with argumentation activities in learning can improve cognitive abilities (Yusiran & Siswanto, 2016).

Inquiry learning with argumentation activity is the learning with inquiry steps which is billed the argumentation ability in the form of claim made and ground used. Claim made and ground used indicators were trained in the step in research question and testing the hypohotesis. The ground used indicator was trained to the step of formulating the hypothesis.

Inquiry learning with argumentation activities needs to be supported by the existence of learning resources that train students to become independent learners, one of them is the student worksheet. Guided inquiry-based student worksheet can improve student learning outcomes and the average learning outcomes obtained by students are higher (Annafi, et al., 2015).

Based on the description above, the objective of this research was to describe the validity and effectiveness of student worksheet based on inquiry by design argumentation activity in the Bryophyte.

METHOD

This developmental research referred to Fenrich model (1997) including analysis, planning, development, implementation, evaluation and revision. This research was carried out during 24-26 April 2019. The research was begun by analysis, planning, and development stage in Biology Department, Mathematics and Natural Sciences Faculty, Universitas Negeri Surabaya. The implementation conducted limitedly in SMA Negeri 18 Surabaya involving 12 students of X class majoring in mathematics and natural science 2018/2019 academic year.

The validity of student worksheet based on the validation by an education expert, as well as the validation of a Bryophyte material expert, and biology teacher. The data was collected by employing validation method. Then, it was analyzed based on its average. The component assessed were design, content, and language. Minimal score of validation result was 2.8 and included as valid (Ratumanan & Laurens, 2006).

The effectivity of student worksheet based on test by students. Test results were assessed with a range of 0-3 for which each score is the level of argument obtained. Level 0 was no claim made; level 1 was a claim made irrelevant to the data; level 2 was claim made accompanied by weak data; and level 3 was claim made accompanied by appropriate data. Test results was percentage score by calculating using this formula.

$$argumentation\ ability = \frac{score\ obtained}{total\ score} \times 100\%$$

The limit score of argumentation ability was >62.50 and was included as good argumentation (Asy'ari, 2015).

RESULTS AND DISCUSSION

This research was a developmental research of student worksheet based on inquiry by design argumentation activity in Bryophyte. Student worksheet based on inquiry by design argumentation activity was sheet that contain about picture of Bryophyte, argumentation questions, and inquiry steps. This student worksheet was developed to trained argumentation ability. Argumentation ability was trained with valid media.

The validity assessment of the student worksheet was done through the process of validation by education expert, as well as the validation of a Bryophyte material expert, and biology teacher. Based on the validation results, it is known that the student worksheet had the validity with design, content, and language with very valid category (Table 1).

Table 1. The Validity Result of Student Worksheet with Bryophyte based on Inquiry by Design Argumentation Activity

Valued Aspect	Average	Category
Design		
- Visual of student worksheet	4	Very valid
- Cover design	4	
- Title of student worksheet	4	
- Time allocation	3.67	
- Learning objectives	4	
- Student worksheet instruction	4	
- Picture	4	
- Systematic visual	4	
Average	3.96	Very valid
Content		
- Conformity of the material with the concept	4	Very valid
- Appropriate step of inquiry	4	
- Based on inquiry with argumentation activity	4	
Average	4	Very valid
Language		
- Use of the term	4	Very valid
Average	4	Very valid
Average	3.97	Very valid

The developed student worksheet belongs to a very valid category with a score of 3.97. The results of this student worksheet validity in all aspects but there was one aspect that gets a score of 3. The highest score of student worksheet validity were 4 in design aspects except time allocation, content aspects, and language aspect. This showed that this student worksheet were very valid and able to implemented in the learning activity (Ratumanan & Laurens, 2006).

The main aspects of the assessment of the student worksheet were about inquiry steps accompanied by argumentation activities. It obtained a score of 4. This aspect was about problem formulation with some open questions contained argumentation indicators, namely claim made and ground used. Problem formulation was a specified step in the success of inquiry learning activities (Sanjaya, 2014). Students were able to formulated problems with questions that contained argumentation indicators (Duschl, 2007).

Argumentation ability can be trained to students with this student worksheet. It means that there were learning objectives, space to write down the answer and the steps of learning activities must be clear. The formulation of learning objectives which was a suggestion from the supervisor at the student worksheet aims that students know the goals that must be achieved in learning and can increase learning motivation. In addition, the student the student worksheet was also given sufficient space to write down the answers and on the cover the student worksheet was given space to write down the name of the group. The language used in student worksheet learning was tailored to students' understanding and clear sentence compilation so that students understand the steps that must be taken in the student worksheet (Darmodjo, et al., 1992). The steps of collect the data must be easily so that the students can be easily understood. Collecting data is a very important step in inquiry learning to find the concepts that are asked or to be discovered (Sanjaya, 2014) so that the writing of the procedures or instructions presented must be able to be well prepared and in accordance with student's understanding.

Score validity with the lowest score of 3 on design aspect about time allocation. The time allocation for Plantae material was 6x45 minutes. It means that for each meeting has 2x45 minutes. It will be better if the time allocation of this student worksheet has 2x45 minutes, so it needs to do revision for the student worksheet improvements.

The effectiveness results of this student worksheet can be seen from the results of student argumentation tests. The test results that have been followed by 12 students showed that the students were

good argumentation got percentage of 75% (Table 2). It shows that student worksheet based on inquiry was able to train students' argumentation ability.

Table 2. The Results of Students' Argumentation Ability

No.	Student	Score	Argumentation Criteria
1.	1	80	Good
2.	2	80	Good
3.	3	80	Good
4.	4	80	Good
5.	5	80	Good
6.	6	86	Very good
7.	7	66	Good
8.	8	80	Good
9.	9	60	Not good
10.	10	80	Good
11.	11	47	Very bad
12.	12	80	Good

The percentage gain from argumentation tests was 75% included as good argumentation. 25% of students were very good, not good, and very bad argumentation criteria. This showed that argumentation ability of students was difference. The difference of argumentation ability was caused by different cognitive levels and students were not accustomed to working open questions. Students' argumentation were good caused by student were active in learning with this student worksheet and students understand the concept. Duschl (2008) stated that the first thing in mastering argument was that a person must have the knowledge of good concepts such as scientific theories, models, and laws that underlie a concept. One's argumentation ability showed the extent of understanding the concepts, skills, and abilities of scientific reasoning (Osborne, 2010).

Students were not good and very bad argumentation were caused by student involvement was lacking, several internal factors faced by students, and insufficient understanding of concepts. It means argumentation ability was rarely mastered by everyone (Farida & Widia, 2014). It shows that argumentation ability was not a spontaneous ability possessed by someone but must be trained. This student worksheet was one of the guiding steps to train and developed the argumentation ability of students. The argumentation ability can be trained by answering open questions that require students to write claims and data. One example of the problem found in the student worksheet was, "Bryophyte is only about 2-3 cm tall. What causes the Bryophyte to only have a few centimeters? (claim

made) What reason makes you give the answer? (ground used)."

Test of argumentation ability represented some of the cognitive aspects of students. The cognitive level of students was showed in in Figure 1 as follows.

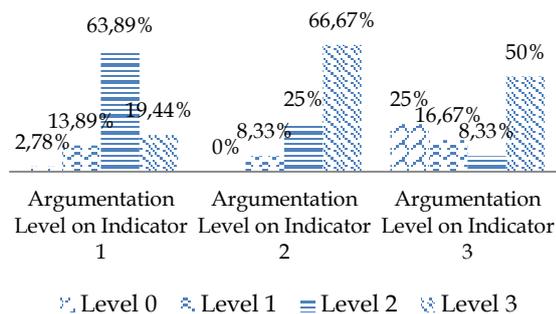


Figure 1. Argumentation Level of Each Indicator

- Noted:** Indicator 1 : explain the the relation of the characteristics of Bryophyte to their role in life (category C2/ understanding)
- Indicator 2 : classify Bryophyte in Plantae (category C4/analysis)
- Indicator 3 : analyze the results of observations, phenetic and phylogenetic (C4 category/analysis)

Based on the argumentation test, it can be seen that most of student got level 2 and level 3 with 75% of the sample of students having been able to argue well. Level 3 arguments were arguments by writing claims accompanied by supporting data (Ginanjar, et al., 2015). An example of level 3 argument was "Pogonatum and Polytrichum are closely related. This is based on the dendogram of both Bryophyte (group II) which indicates that the kinship is close because of the slight / not too far morphological differences."

The differences of argumentation level for each student was caused by the differences of cognitive level on each number test and the differences of cognitive level every students. Indicator 1 in the argumentation ability test was included in the cognitive level C2 (comprehension) so that more students were able to write arguments. Most of the students can wrote arguments with weak data. It means that students can make a good claim. This happened because in learning with student worksheet students were used to making claim. Ground used was a support data for claim made so that students need more literature to make a valid argument. Wojdak (2010) stated that valid argumentation was obtained by critical analysis and makes a logical argument.

Indicator 2 had the cognitive level of C4 (analysis) and students were able to write good arguments at level 3 of 66.67%. Grouping was one of

the verbs in the C4 cognitive level which was easier to trained students after the previous cognitive level. In addition, the questions written were also still related to learning in the student worksheet so that students were able to write good arguments. Learning activities with student worksheet involved all students to observation Bryophyte by themselves. It means students understand the concepts learned so students can make arguments supported by appropriate data. It shows that inquiry can be trained the argumentation ability and scientific explanation (Shu, 2015).

Indicator 3 was a question about explaining as included in the C4 cognitive level. 50% of students were able to write arguments at level 3 and level 0 at 25%. Questions based on indicator 3 were questions in the Higher Order Thinking (HOT) category so that most students were still difficult to give answers because they have not been trained in writing down reasons. It caused by students were not accustomed to writing HOT answers. The second highest percentage of this indicator was 25% in level 0. It means that students were not used to writing arguments. It was in accordanced with Sampson's statement, et al., (2010) that argumentation skills need to be trained and cannot be done in a short time. This student worksheet required students to practice thinking and find concepts about Bryophyte through observation. This was supported by inquiry steps to collect data and instructions written clearly and easily understood by students. Easy-to-understand instructions get a score of 4 by the validator so that when students did the learning process it can run smoothly. In addition to the stage of collecting data, students have been trained to think in the steps of formulating questions and formulating hypotheses. The exercises given in the student worksheet were experiences given by the teacher so that students can get good learning outcomes.

Inquiry learning with argumentation activity can make student easy to understand a concept. It was in accordanced with the findings of several studies stated that the learning process in which students train to argue science can further enhance students' ability to master the concept (Zohar, 2002; Mc. Neil, 2006; Sampson, 2010; Muslim, 2012). Through argumentation activities, students become more skilled in expressing their arguments accompanied by the right reasons, so that they will further enhance students' cognitive abilities (Siswanto, 2014; Yusiran, 2016).

Based on the validity and the effectiveness, argumentation ability can be trained supported by the existence of valid learning media. The student worksheet based on inquiry by design argumentation in

Bryophyte can trained argumentation ability and students got a concept by themselves.

CLOSING

The developed of student worksheet based on inquiry by design argumentation activity in Bryophyte were very valid (Ratumanan & Laurens, 2006). It based on the result of validation from three aspects namely design aspect, content aspect, and language aspect that got average score of 3.97. This student worksheet can be implemented in the biology learning. Inquiry learning in this student worksheet can be trained argumentation ability. It shows with 75% of students can made good arguments and 60.19% of students can made a claim made with data.

ACKNOWLEDGEMENTS

The researchers would like to thank to Dra. Wisanti, M.S. as validator and reviewer, Dr. Raharjo, M.Si. as validator and reviewer, and Rusdiyanto, S.Pd. as validator and also the students of X MIPA 4 SMA SMA Negeri Surabaya.

REFERENCES

- Annafi, N., Ashadi, & Mulyani, S. 2015. Pengembangan Lembar Kegiatan Peserta Didik Berbasis Inkuiri Terbimbing pada Materi Termokimia Kelas XI SMA/MA. *Jurnal Inkuiri*, 4 (3): 21-28.
- Arifin. 2000. *Strategi Belajar Mengajar*. Bandung: Jurusan Pendidikan Kimia FMIPA UPI.
- Asy'ari. 2015. *Metodologi Penelitian*. Jakarta: Salemba Empat.
- Badan Standar Nasional Pendidikan. 2010. *Paradigma Pendidikan Nasional Abad XXI*. Jakarta: BSNP.
- Bricker, L.A., & Bell, P. 2008. Conceptual of Argumentation from Science Studies and The Learning Sciences and Their Implication for Practices of Science Education. *Science Education*, 92 (3): 473-498.
- Darmodjo, H. & Jenny R.E. 1992. *Pendidikan IPA*. Departemen Pendidikan dan Kebudayaan: Proyek Pembinaan Tenaga Kependidikan Direktorat Jenderal Pendidikan Tinggi.
- Duschl, R. A. 2007. *Taking Science to School: Learning and Teaching Science in Grade K-8*. Washington: National Academic Press.
- Farida, Ida Ch. & Widia, F.G. 2014. Profil Keterampilan Argumentasi Siswa pada Konsep Koloid yang Dikembangkan Melalui Pembelajaran Inkuiri Argumentatif. *Edusains* 6 (1): 32-40.
- Fenrich, P. 1997. *Practical Guidelines for Creating Instructional Multimedia Applications*. Forth Worth: The Dryden Dress.
- Ginanjari, S., Handayani, P., Sardianto, M.M.S. 2015. Analisis Argumentasi Peserta Didik Kelas X SMA Muhammadiyah 1 Palembang dengan Menggunakan Model Argumentasi Toulmin. *Jurnal Inovasi dalam Pembelajaran Fisika*, (2) 1.
- Harlen, W. 2014. Helping Children's Development of Inquiry Skills. *Inquiry in Primary Science Education* 1: 5-19.
- Hendratmoko. 2016. *Pengembangan Perangkat Pembelajaran Fisika Model Inkuiri Terbimbing Terintegrasi Ilmiah Siswa* (thesis tidak dipublikasi). Surabaya: Universitas Negeri Surabaya.
- Inch E.S., Warnick B., Endres D. 2009. *Critical Thinking and Communication: The Use of Reason in Argument* (Fifth Ed.). Boston: Pearson Education.
- Lemke, J. 1990. *Talking Science, Language, Learning and Values*. Norwood: Ablex.
- Mc. Neil, K. L., Lizotte, D. J., & Karjcek, J. 2006. Supporting Student's Construction of Scientific Explanations by Fading Scaffolds in Instructional Materials. *The Journal of The Learning Science*, 15 (2), 153-191.
- Muslim, Suhandi, A. 2012. Pengembangan Perangkat Pembelajaran Fisika Sekolah untuk Meningkatkan Kemampuan kognitif dan Keterampilan Berargumentasi. *Jurnal Pendidikan Fisika Indonesia*, 8:174-183.
- Osborne, J. 2010. Arguing to Learn in Science: "The Role of Collaborative, Critical Discourse. American Association for the Advancement of Science". 1200 New York Avenue, Washington, DC 20005.
- Rahmad, B.W. 2018. Pengembangan Perangkat Pembelajaran Berbasis Inkuiri Terbimbing untuk Melatihkan Kemampuan Argumentasi Ilmiah Mahasiswa pada Materi Transpor pada Tumbuhan. Tidak Dipublikasikan *Thesis*. Surabaya: Universitas Negeri Surabaya.
- Ratumanan, T.G., & Laurens, T. 2006. *Evaluasi Hasil Belajar yang Relevan dengan Kurikulum Berbasis Kompetensi*. Surabaya: Unesa University Press.
- Roshayanti, F. 2012. Pengembangan Model Asesmen Argumentatif untuk Mengukur Keterampilan Argumentasi Mahasiswa pada Konsep Fisiologi Manusia. *Disertasi*. Bandung: Universitas Pendidikan Indonesia.
- Sampson, V., & Gerbino, F. 2010. Two Instructional Models That Teacher Can Use to Promote &

- Support Scientific Argumentation in the Biology Classroom. *The American Biology Teacher*, 72 (7): 427-431.
- Sanjaya, W. 2014. *Strategi Pembelajaran Berorientasi Standar Proses Pendidikan*. Jakarta: Fajar Interpratama Mandiri.
- Shu, Chih-Chao. 2015. Enhancing Skill in Constructing Scientific Explanations Using a Structured Aargumentation Scaffold in Scientific Inquiry. *Computers & Education*, 91: 46-59.
- Siswanto, -, Kaniawati, I., & Suhandi, A. 2014. Penerapan Model Pembelajaran Pembangkit Argumen Menggunakan Metode Sainifik untuk Meningkatkan Kemampuan Kognitif dan Keterampilan Berargumentasi Siswa. *Jurnal Pendidikan Fisika Indonesia*, 10(2), 104-116.
- Wojdak, J.M. 2010. An Attention-Grabbing Approach to Introducing Students to Argumentation in Science. *BioscienceEducation*.
- Yusiran, Y., & Siswanto, S. 2016. Implementasi Metode Sainifik Menggunakan Setting Argumentasi pada Mata Kuliah Mekanika untuk Meningkatkan Kemampuan Kognitif Mahasiswa Calon Guru Fisika. *Jurnal Penelitian dan Pengembangan Pendidikan Fisika*.
- Zohar, A., & Nemet, F. 2002. Fostering Students Knowledge and Argumentation Skills Through Dilemmas in Human Genetics. *Journal of Research in Science Teaching*, 39 (1), 35-62.