



Socio Scientific Issues-Based Argumentation Assessment for Middle School Students

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Abstract: This research was conducted to produce an Argumentation Assessment based on Scientific Social Issues. This study uses the R&D method. This research is in the Develop stage, namely conducting expert validation and limited trials. The SSI-based argumentation instrument trial was conducted on 15 and 30 grade IX students of SMP Adik Irma Jakarta. Data collection techniques were carried out by written tests and assessment of argumentation test questions. The assessment of argumentation test questions is given to material experts and 10 teachers. The CVI test was conducted by ten teachers, in an average CVI score of 0.9 with a very appropriate category. The first trial was conducted with ten written tests, resulting in six assessments that were declared valid and reliable with a validity test value > 0.514 and a Cronbach's Alpha reliability test score > 0.514 . Furthermore, the second trial was carried out on thirty students with five assessments, resulting in Validity Test scores > 0.361 , Reliability Test scores > 0.361 , and the developed assessment was able to measure students' argumentation skills at level three according to the Toulmin Analysis Pattern (TAP). The conclusion is that the assessment developed can be used by teachers to measure students' argumentation skills.

Keywords: Assesment; Socio-Scientific Issues (SSI); Argumentation skill

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Introduction

The renewal of the learning process in the 2013 Curriculum lies in learning that emphasizes the modern pedagogic dimension, namely using a scientific approach. The steps of the scientific approach in the learning process include digging up information through observation, asking, experimenting, then processing data or information, presenting data or information, followed by analyzing, reasoning, then concluding, and creating (Wilsa et al., 2017).

The scientific approach is used to hone soft skills, one of which is argumentation skills. Argumentation skills are important and must be possessed by students, so that students can weigh various issues from the aspect of benefits, drawbacks and impacts received from a scientific product. Issues related to science and emerging in the community and involving moral and ethical components are known as Socio Scientific Issues (SSI)

(Nurhayati, et. al., 2016). This is reinforced by the opinion of Callahan (2009) which says that SSI is a learning strategy that presents science material in the context of social issues by involving moral or ethical components (Oktaviana et al., 2020).

SSI is a problem in social life that is conceptually closely related to science (Anagün & zden, 2010) with a relative or uncertain answer. SSI refers to dilemmatic social issues related to science conceptually, procedurally and technologically. SSI can be found in global contexts, such as genetic engineering issues (gene therapy, cloning or stem cells) and environmental issues such as global warming and climate change (Tekin, et. al., 2016). The SSI approach in science learning provides an understanding of learning material by reviewing an issue or learning topic from various points of view (Asi et al., 2021). Paraskeva, et al. (2015) argues that socio-science issues in biology, such as conservation, sustainable use of biodiversity, and human impacts on

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local and global ecosystems are complex, controversial, and real-world problems that require multi-disciplinary solutions involving social approaches, economics, ecology, ethics, therefore can be the basis of scientific literacy education (Suwono, 2015).

SSI is a complex, contemporary, usually unstructured and socially related scientific problem that is often debated and has no absolute solution. Students need scientific knowledge for sound decision making, and can encourage active student participation and the development of argumentation skills (Christenson et al., 2012). Widhy, et al. (2013) in his research raised SSI related to the impact and influence of the eruption on the environment and the consequences of mounting garbage and so on. All things that are the meaning of science in life, and all of that can be studied and understood carefully so that they become a reference in producing solutions to the problems faced later.

Research conducted by the Chinese government (2001) states that improving communication and collaboration skills is very important to achieve scientific literacy. Scientific literacy is an excellent asset for students to master the meaning of science itself (Chung et al., 2014). Scientific literacy can be developed through thinking processes such as critical reasoning. Critical reasoning process according to Binkley et al. (2012) can be categorized into several categories, namely knowledge, skills, and attitudes; where the knowledge aspect includes: (a) reasoning effectively, using systems thinking, and evaluating evidence; (b) solving problems; and (c) articulate clearly. Skills include: (a) reasoning effectively and (b) using systems thinking. Attitudes include: (a) making reasonable judgments and decisions, (b) solving problems, and (c) attitude disposition (Liu et al., 2014).

The results of research Hasnunidah, et al. (2007) showed that the percentage of student involvement in discussions and responding to problems was still low. The low discourse of students' argumentation has an impact on the quality of their arguments. The causal explanations for the given phenomena are often unrelated, and the evidence developed is unsupportive and irrelevant. In line with the data from the descriptive study conducted by Roshayanti et al. (2009) it is known that the low profile of the sociocultural perspective argues that students are caused by the low percentage of student involvement in discussions and responding to problems (Roshayanti & Rustaman, 2013).

Science learning that is carried out is not just understanding concepts, but there are other abilities in students that must be formed, improved and or developed, one of which is the ability to argue. Arguments in the concept of science state that science learning is carried out not only mastering scientific concepts, but learning how to play an active role in scientific argumentation (Budiyono, 2016).

Suprijono (2011) states that the problem solving process is not a simple thinking process, through argumentation skills students have a foundation of critical and logical thinking in solving problems scientifically and gradually because students' arguments must be equipped with supporting scientific data and evidence (Fatmawati & Ramli, 2018).

Hakyolu & Bekiroglu (2011) state that scientific argumentation has the meaning of building a sociocultural activity through presentation, interpretation, criticism, and revision of an argument or opinion (Zuhriyah et al., 2019). Furthermore, Kuhn (2009) defines argumentation as a statement accompanied by truth (Amalia, et. al., 2018). So argumentation is one of the results of higher-order thinking processes that are needed by students in studying science.

Argumentation, a specific form of rhetorical persuasion, is a core factor in science and science teaching. Inquiry has been identified as an important attribute of science. However, argumentation has been accepted as another important attribute of science. Therefore, argumentation for learning is an important literacy practice and is a contributing component to the nature of science that can lead to the construction and understanding of knowledge as derived literacy (Chin et al., 2015).

Scientific argumentation has its own characteristics, especially its relation to claims, evidence and justifications; the assessment of the quality of the argumentation that refers to the Toulmin's Argument Pattern (TAP) is considered to be able to improve the quality of the argumentation (Probosari, 2016).

Educational Assessment according to Permendiknas Number 20 of 2007 concerning Educational Assessment Standards is the process of collecting and processing information to determine the achievement of student learning outcomes. The principles and standards of assessment emphasize two main ideas, namely that assessment should improve student learning and assessment is a valuable tool for making teaching decisions (Budiman & Jailani, 2014).

Assessment or assessment is needed in learning. The existence of an assessment serves to measure students' abilities, both from the cognitive, affective and psychomotor domains after learning takes place. In addition, the assessment can also be used to measure students' critical thinking, creative thinking, and argumentation skills. The assessments that are commonly used or commonly encountered are in the form of questions, be it multiple choice questions, descriptions, or essays.

Higher order thinking skills have become one of the priorities in science learning. Junior high school students should have been trained to carry out higher order thinking processes according to their age.

Permendikbud Number 81a of 2013 concerning Curriculum Implementation in Appendix I of the Guidelines for Preparation and Management of the Education Unit Level Curriculum which states that the abilities of students needed include the ability to communicate, think critically and creatively (Budiman & Jailani, 2014). High-level skills can be trained with proper assessment.

Biotechnology is one of the materials in science that is always evolving from time to time. As science and technology develop, biotechnology will always experience development. Where, developments that occur will result in data-based or reality-based issues that are always interesting for the general public to respond to so that they can become debates, even more so among academics, including students as a generation that will face the development of science and technology more than today.

Several studies on assessment development have been carried out. Sundari (2014) developed an assessment based on character values. Then, the development of an assessment carried out by Irsyad &

Sukaesih (2015), in their research developed an authentic assessment of the interaction of living things with the environment to improve students' critical thinking skills. Then the research conducted by Roshayanti & Rustaman (2013), the research carried out is the Research and Development (R & D) method with a focus on improving argumentation skills in the concept of human physiology through the development of an argumentative assessment model as outlined in the form of group argumentation observation sheets.

Based on the results of these studies, no one has developed an argumentation assessment based on SSI. Issues that develop in society can be explained from the aspect of science. Therefore, in this study, an SSI-based argumentation assessment was developed to measure students' ability and level of argumentation.

Method

The stages in the process are presented in a research scheme, as follows:

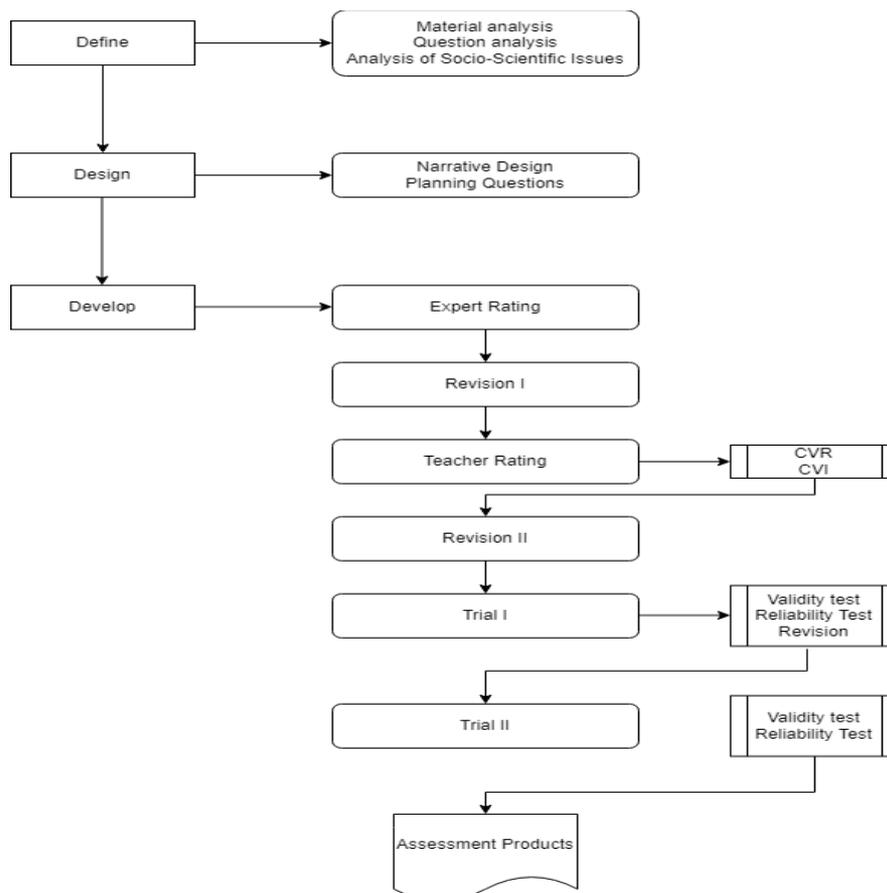


Figure 1. Schematic of the Research Process

This research method uses the Research and Development (R&D) method. This research is in the Develop stage, namely conducting expert validation and limited trials. The SSI-based argumentation instrument

trial was conducted on 15 and 30 grade IX students of SMP Adik Irma Jakarta. The data collection technique was carried out with a written test and an assessment of argumentation test questions. The assessment of

argumentation test questions is given to material experts and 10 teachers. The written test is in the form of an assessment that has been developed which consists of narratives and graded questions. The checklist generated data for content validation, while the written test produced data for the validity test, reliability test and the complexity of students' argumentation skills.

Result and Discussion

The ability of argumentation needs to be possessed by students. This can be measured using an argumentation test. SSI-based argumentation instruments on biotechnology materials have been developed through the define, design, and develop stages with the following results:

Define

Several stages were carried out at the defining stage, namely material analysis, question analysis, and SSI issue analysis. The results of the analysis of Biotechnology materials show the following information: Biotechnology materials are given to 9th grade students in even semesters; Biotechnology materials taught are conventional and modern biotechnology; The conventional biotechnology materials studied are fermentation; and the modern biotechnology materials studied are tissue culture, transgenic plants, artificial insemination, cloning, and test-tube baby.

The results of the analysis of the assessment that have been carried out show that biotechnology material questions often appear in the form of closed and open type questions without biotechnology issues that are developing in the community and there is no argumentation ability assessment.

The analysis carried out related to biotechnology resulted in the findings, namely cloned humans are born; GMO Rabbits Glow like Fireflies; Chinese Scientists Engineering Baby DNA to Prevent HIV; Genetically Engineered Blue Rose; Inul Daratista Conducts IVF Program; Genetically Engineered Mosquito A Powerful Weapon Against Zika; Ministry of Agriculture Uses Biotechnology to Develop Genetics of Twin Cows; Stem Cell Technology, New Way to Treat Stroke, Heart and Diabetes Diseases; Immediately Marketed, "Genetic Editing" Fruits and Vegetables; and A Vaccine That Could Stop Mosquito Spreading Malaria.

Design

The argumentation assessment is designed by presenting modern biotechnology issues, while the questions presented are based on Toulmin's Argument Pattern (TAP). The presentation of the assessment begins with biotechnology issues that are developing in the community, followed by closed and open questions. The assessment designed has been adapted to the thinking processes of class IX SMP/MTs students. Some examples of argumentation assessment designs are listed in Table 1.

Table 1. SSI-based argumentation assessment design

Design	
Narrative (SSI)	<p>SSI-2 <i>GMO Rabbits Shine like Fireflies</i> A group of rabbits born at the University of Istanbul, Turkey is different from rabbits in general. The difference is that the rabbit can glow in the dark. This is because the researchers inserted a jellyfish gene that produces a protein that causes the rabbits to glow when exposed to ultraviolet light. Source: https://sains.kompas.com/read/2013/08/20/0543404/Kelinci.Transgenik.Bercahaya.bak.Kunang-kunang</p>
Graded question	<p><i>Question</i> Do you agree about the existence of glowing rabbits? Give your opinion about the existence of a glowing rabbit!</p>
Narrative (SSI)	<p>SSI-6 <i>Genetically Engineered Mosquito A Powerful Weapon Against Zika</i> The Zika virus outbreak is a global health problem. British scientists are among those trying to find action to contain the outbreak. They genetically engineer millions of mosquitoes. Those millions of mosquitoes will be released in countries affected by the Zika virus. Trials have been carried out in Brazil, the results show that genetically modified mosquitoes have caused a decline in the population of Aedes Aegypti mosquitoes by up to 90 percent. The decline in the Aedes Aegypti mosquito has caused dengue fever cases to drop dramatically to 99 percent. Source: https://www.cnnindonesia.com/gaya-hidup/20160208160310-255-109594/nyamuk-rekayasa-genetik-dianggap-senjata-ampuh-lawan-zika</p>
Graded question	<p>Do you agree with the Genetic Engineering being carried out? Give your opinion about it!</p>

Develop

Expert Assessment Results

Material expert assessment is carried out to determine the quality of the assessment that has been developed. The material expert conducts an assessment of the SSI-based assessment then provides suggestions and input according to the material expert assessment grid. The results of the expert assessment show are in Table 2.

Table 2. Expert assessment results

Test type	Expert 1 (%)	Expert 2 (%)
Narrative eligibility	92	100
Eligibility of inquiries	98	99

Table 3. Suggestions and Improvements

Aspect	Expert Advice	Repair
Word Standard	change non-standard words into standard	Words become standard
The issues presented are issues related to modern biotechnology and closely related to society.	Include narrative source (SSI)	Include sources
Question	Make graded questions	Multilevel (consisting of closed and open questions)

Revision 1

The improvements made included the standard aspects of words: improvements were made because there were still words that were not in accordance with the rules of the Big Indonesian Dictionary, article sources: the source of articles that had been used as narratives (SSI) had not been included, and question aspects: the questions presented were not graded questions. , so it should be turned into a nested question. The improved assessment based on expert advice was then assessed by ten teachers.

Teacher Rating

This SSI-based argumentation assessment was developed to assess the argumentation ability of SMP/MTs students. Therefore, the assessment quality test was also carried out by science teachers who teach at MTs and SMP, totaling ten teachers. Assessment assessment includes narrative feasibility (SSI) and questions using the CVR and CVI methods. Based on the table of critical values of CVR and CVI for ten validators with a significance level of 95% ($\alpha=0.05$), the critical value is 0.520. That is, an item is declared valid if the CVI value is > 0.520. However, if the CVI value < 0.520; then the item is not received or requires repair. The CVI gain based on the teacher's assessment of the SSI-based assessment is shown in Table 4.

Table 4. Obtaining CVI from Teacher Assessment

Assessment Aspect	CVI	Description
Narrative (SSI)	0.97	Valid
Question	0.94	Valid

The results of the expert assessment show that the average for the feasibility of the narrative is 96% and the feasibility of the questions is 98.5%. Thus, overall, from the aspect of the feasibility of the narrative and questions, the average percentage of eligibility is 97% with a very good category (SB). These results indicate that SSI-based argumentation assessment can be used to test students' argumentation skills on Biotechnology material. In addition to providing an assessment, the two experts also provided suggestions and input. Expert suggestions and input as well as improvements made are in Table 3.

Table 4 shows the argumentation assessment based on the SSI that was developed is valid and can be tested on grade IX students of SMP/MTs. However, there are still improvements to be made.

Revision 2

The improvements made were focused on the simplicity of the sentences on the issues presented. According to input from the teachers, they stated that the narrative sentences given were too long, thus making the reading time too long. So, there needs to be a simplification of sentences to streamline processing time.

Trial 1

The results of the 1st trial conducted resulted in the quality of students' arguments with an average percentage of 70% in the good category. In addition, data obtained from the Product Moments validity test and Alpha Cronbach reliability test, both of which were assessed using the IBM SPSS Statistic version 25 application. The R values of the validity and reliability test tables were 0.412 and 0.514 respectively. The results of the calculation of the validity and reliability tests are in Table 5.

From the table, it can be concluded that of the ten tested assessments, six assessments have a validity value > 0.412, while the reliability for ten assessments has a value > 0.514. Meanwhile, the assessment that has been developed can measure students' argumentation skills at level 2.

Table 5. Validity and Reliability test results for trial 1.

Asesment	Validity value	Reliability Value	Descriptions
Ass_1	0.359	0.640	Not valid
Ass_2	0.684		Valid
Ass_3	0.623		Valid
Ass_4	0.753		Valid
Ass_5	0.136		Not valid
Ass_6	0.605		Valid
Ass_7	0.366		Not valid
Ass_8	0.744		Valid
Ass_9	0.014		Not valid
Ass_10	0.718		Valid

Trial 2

Trial 2 which was carried out after an improvement from the results of trial 1, trial 2 (large scale) was given to 30 class IX (Nine) students of SMP Adik Irma, the data obtained from the Product Moments validity test and Alpha Cronbach reliability test, both assessments used IBM SPSS Statistic version 25 application. The R values of the validity and reliability test tables are 0.361 and 0.361 respectively. Here are the results of the calculation:

Table 6. Validity and Reliability test results for trial 2

Asesment	Validity value	Reliability Value	Descriptions
Ass_2	0.707		Valid
Ass_3	0.661		Valid
Ass_4	0.566	0.656	Valid
Ass_6	0.500		Valid
Ass_10	0.548		Valid

Based on the data in the table, information is obtained that the product moment's validity test value for each assessment is > 0.361 so it can be concluded that the assessment that has been developed is valid. Meanwhile, for Cronbach's Alpha reliability test, Cronbach's Alpha value was obtained > 0.361 so it can be concluded that the assessment that has been developed is consistent, so the assessment is feasible to use. In addition to getting test scores for validity and reliability tests, an overview of the assessments that have been developed can measure students' argumentation skills at level 3.

Based on the results of research and development that has been carried out based on Socio-Scientific Issues assessments on biotechnology materials, it has met the feasibility of presenting the issues and questions given with a description of the following characteristics, namely the use of biotechnology issues that have been circulated and consumed by the public such as cloning, GMOs, DNA engineering, Genetic Engineering, IVF, and Stem Cells; become the basis for students' sources of information to then answer stratified questions, while the presentation is in the form of a simplified narrative but does not eliminate the core of the problem.

The graded questions presented have been narrowed down, starting with questions that must be answered with a statement (claim) in the form of "yes" or "no", after being presented with questions that motivate students so that the form given is in the form of correct information (data), justification, support and or rebuttals. All answers generated by students are presented in written form.

The assessment developed can be said to be feasible to use because it looks at the CVI value, validation value and reliability value. The validity of the results of this development is appropriate when viewed from the level of content validity by experts according to Nieveen (Agustin et al., 2015) and according to Asikin et al. (2017), at least it must meet 3 criteria, namely valid, practical and effective. A product or program is said to be valid if it reflects the state of the art of knowledge, which can also be called content validity. A product is said to be practical if the person who uses the product thinks that the product in question is usable. While the product is called effective if the product provides results in accordance with the objectives that have been set.

Based on the results of the development of the Socio-Scientific Issues (SSI)-based student argumentation assessment on biotechnology material, it has met the elements that have been mentioned, so it can be said that the assessment that has been developed meets the appropriate criteria to be used as a tool for measuring students' argumentation ability, especially on biotechnology material in the eyes. IPA class IX SMP/MTs .

Conclusion

Based on the results and discussion, it can be concluded that the SSI-based assessment developed is composed of SSI from valid sources and graded questions according to the characteristics of SMP/MTs students are said to be feasible and can be used for SMP/MTs students; because it has gone through the Expert test, validity test and reliability test and shows valid and reliable results. In addition, the assessment that has been developed can measure argumentation ability up to level 3.

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