Innovative learning model for improving students’ argumentation skill and concept understanding on science

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Abstract. Argumentation skill is the ability to compose and maintain arguments consisting of claims, supports for evidence, and strengthened-reasons. Argumentation is an important skill student needs to face the challenges of globalization in the 21st century. It is not an ability that can be developed by itself along with the physical development of human, but it must be developed under nerve like process, giving stimulus so as to require a person to be able to argue. Therefore, teachers should develop students’ skill of arguing in science learning in the classroom. The purpose of this study is to obtain an innovative learning model that are valid in terms of content and construct in improving the skills of argumentation and concept understanding of junior high school students. The assessment of content validity and construct validity was done through Focus Group Discussion (FGD), using the content and construct validation sheet, book model, learning video, and a set of learning aids for one meeting. Assessment results from 3 (three) experts showed that the learning model developed in the category was valid. The validity itself shows that the developed learning model has met the content requirement, the student needs, state of the art, strong theoretical and empirical foundation and construct validity, which has a connection of syntax stages and components of learning model so that it can be applied in the classroom activities.

1. Introduction

Argumentation is an important skill need to be developed in science learning process [1]. Furthermore, there are three factors that makes argumentation skill important in science learning, i.e. improving high-level thinking processes through social interaction activities with language media; developing students’ scientific arguments supported by relevant evidence through the process of learning, assignment, and modelling of teachers, and improving students’ conceptual understanding. The skill of argumentation is not an ability that can develop itself along with the human physical development. Rather, it should be developed through a stimulus process that requires a person to be able to argue. Thus, junior high school students need to be trained to argue so that the skills of argumentation and understanding of the concept of science can be improved.

A preliminary research carried out by Astuti, Suyono, and Nur [2] shows that students' argumentation skill at Malang city, Indonesia is still low with average score 28.07%. In particular, the score of argumentation skill is indicated by some indicators as follows: ability to make a claim (35.35%); showing evidence that can support claim (30.41%); setting up reasons that support claim (25.67%), and conveying counter of claim (20.85%). In addition, the results of science concept understanding tests conducted on students in one of junior high school at Malang city showed understanding of student
concept is still low with the average score of 44.43% [2]. In particular, the score of each conceptual understanding indicators is as follows: formulating concept definition (47.63%), determining critical attribute (45.78%), determining variable attribute (40.54%), and mentioning example and non-example (43.87%).

The learning model that aims to improve the skill of argumentation and understanding of science concept in junior high school level, indeed, has been developed by Chin and Osborne [3] with QA model (Question Argumentation). The QA model has several advantages, namely: (1) has provided potential steps in preparing claims, showing data (evidence) that can be used to strengthen claims, and compile explanations of evidence that can be used to support claims, (2) to practice arguing, and (3) to improve the skill of argumentation and understanding of science concept of junior high school students. Although the QA model has such advantages, it still has several weaknesses, namely: 1) the potential steps of the argument preparation process is still relatively short, 2) it takes much time for discussion activities about claims, proofs, and reasons so that in terms of time becomes inefficient, 3) data that can be used as a statement of evidence that support the claim has been readily provided, 4) has not provided a concept exploration step that provides an opportunity for students to seek evidence either through teaching materials or experiments to develop the skills of the science process.

The advantages and disadvantages of the QA learning model shows that it is still needed an innovation of the QA model. The innovation carried out on the QA model by considering learning strategies to develop students' argumentation skills on science learning has been developed by Simon, Erduran, & Osborne [4]. The results of research conducted Simon, Erduran and Osborne [4] found that a strategy of learning argumentation skills in science developed with six major steps in learning can significantly develop students' argumentation skills. The results of the research of Simon, Erduran and Osborne [4] were further developed by Dawson & Venville [9] on biology subjects. The main results derived from the development of such model are through providing a step to find evidence used in strengthening the argument and a counter argumentation step that requires students to retain arguments and draw up opposing arguments. Based on the advantages and disadvantages of the QA learning model and considering the argumentative learning strategy proposed by Simon, Erduran and Osborne [4] which was further developed by Dawson & Venville [5], this study aimed at producing a valid learning model to improve the skill of argumentation and understanding of science concept of junior high school students.

2. Research method

The development model of the learning model developed in this present study followed the research and development (R & D) designed by Borg & Gall [6] which has 10 (ten) stages, which was then adapted and summarized into 2 major stages: 1) preliminary study and 2) model development.

2.1. Preliminary stage

In this stage, the authors focused on two activities, namely literature study and field survey. The literature study was done by examining the concepts or theories relating to the model of learning developed, while the field survey is aimed to investigate the learning processes conducted by teachers in the classroom as well as the learning resources and the learning facilities used. In addition, it is also to know the initial argumentation skills and understanding the concept of science of junior high school students who were investigated through the test. Based on the results of the preliminary study stage, the formulation of a hypothetical argument learning model is called an argumentative learning model designed to improve the skills of argumentation and understanding of the concept of junior high school students.

2.2. Development stage

2.2.1. Production of learning model

The learning model developed in this study refers to four specific characteristics of model of learning according to Arends [7], namely: 1) a logical theoretical basis, 2) the learning objectives to be achieved, 3) necessary learning behavior (syntax) so that the model can be implemented, and 4) the learning environment needed for the learning objectives can be achieved. The theoretical foundation used in the
The learning model is Jean Piaget's cognitive developmental theory, Vygotsky's social constructivist, information processing, and double code. Based on these theories and indicators of students' argumentation skills and conceptual understanding, student activities are needed to train and improve the skills of argumentation and understanding of concepts. Such activities, for example, include providing activities involving students to focus attention and preparing students to participate actively in the lesson by providing problems to solve through the preparation of initial claims (orientation) and providing activities to look for evidence used in support of claims beginning by exploring the concepts through student textbooks and experimenting so that students are able to develop the skills of the science process.

The necessary learning environments are characterized by the students' active roles in solving problems by constructing claims, exploring and organizing information from student books and student worksheet, experimenting, demonstrating evidence, setting up excuses, drawing up contra-arguments, drawing argument diagrams, and drawing conclusions on the topics that has been studied. Discussion activities are also carried out to construct argument diagrams, put arguments, and maintain the correct concept-based arguments. Based on the above description, it can be formulated skill learning model consists of phases, namely: (1) orientation, (2) exploration, (3) pre-argument, (4) argument and contra-argument, and (5) reflection.

2.2.2. Validation of the learning model
The resulting learning model was then further validated by experts. The validation of the learning model focuses on relevance (content validity) and consistency (construct validity). The expert reviews was carried out by involving 3 (three) experts in the field of chemistry education that has minimum academic qualification of doctoral and has experience in conducting development research. The procedures included asking for the expert judgment on the validity of content and construction of the learning model through a number of Focus Group Discussion (FGD).

3. Results
3.1. Hypothetical argumentation skills learning model

3.1.1. Objectives as the basis for developing learning models
The developed learning model was aimed to achieve 2 main objectives: (1) training and improving skills in arguing and (2) improving understanding on the concept of science of junior high school students. The researcher considered the importance of encouraging argumentation skills because this skill is an important skill that should be developed in science learning [1]. Important argument skills are trained in science learning according to Erduran [1] for three reasons: (1) can improve high-level thinking processes in students through social interaction activities with language media; 2) trained students develop scientific arguments supported by relevant evidence through the process of learning, assignment, and modeling of teachers, 3) can improve conceptual understanding.

3.1.2. Empirical theory and findings underlying the development of the learning model
Claim is a statement or conclusion intended to be accepted by others. This opinion is reinforced by Toulmin [8] stating that claim is a statement or conclusion put forward by a person who thinks and wants to be accepted by the person who is spoken to. Osborne, Erduran, Simon [9] reveals a strategy that can be used to teach students to construct claims in learning argumentation skills using competing theories strategies. According to the strategy, students construct claims by choosing one of the statements of two controversial statements about the phenomenon to be debated [10]. Thus, when choosing a statement or conclusion that is considered correct, then the student must first understand the proposed concept. Therefore, the activity of constructing claims involves cognitive processes in understanding concepts.

The next ability is to show evidence used to support student-made claims. The evidence is a proposed endorsement to strengthen the claim so that others may accept the claim [11]. Similar with Toulmin [8], evidence is an objective fact or condition that can be observed or premise that has been accepted as a truth used to support the claims made. Evidence can be obtained through laboratory activities by
conducting experiments [12]. Experimental activities which is used to conduct investigations can train the skills of the scientific process in obtaining empirical evidence to be used to support conclusions or knowledge claims [13]. The third ability is to formulate reasons. Chaffe [14] reveals the reason is a statement used to support another statement (conclusion) so that the conclusion can be justified. As such, to establish the ability to construct the reason, it is necessary to develop a set of activities that can analyze the relationship between claims, evidence, and reasons to explain why the evidence used can strengthen the claim. The activity is the activity of constructing a complete argument diagram based on the correct concept to illustrate student arguments.

The important strategies to assist students in strengthening arguments consist of claims, evidence, reasons through group discussions. Furthermore, it is stated that through group discussions students can bring arguments, respond to and defend the arguments that have been compiled. In the process of arguing through group discussions involving social interaction to convey their arguments, responding, and maintaining arguments [2]. Therefore, in developing students’ argumentation skills, it is necessary to provide an opportunity for students to practice arguments, to determine whether evidence or data obtained can be used to substantiate the claim, and whether the compiled argument can be used to substantiate the claim, and to determine the relationship between the claims, evidence, and reasons in a diagram. Thus, an activity is needed to conduct inter-group discussion or class discussion, to discuss the argument diagram that has been compiled in the previous activity.

The discussion process and the results of formulating the argument diagrams should be then evaluated and given feedback. This is in line with the opinion of Dawson & Venville [5] indicating that the final step to develop argumentation skills in learning is to provide feedback on the outcome of the discussion. A supportive opinion, Simon, Erduran and Osborne [4] also agreed that an important step in learning arguing skills is to provide feedback on student work. Thus, the activity of the students included in the learning model developed in this study is to draw the conclusions of the material that has been studied and the result of the argument diagram discussed in the previous activity.

3.1.3. Formulation of the Syntax of the hypothetical argumentation skill learning model
The designed learning stage should give students the opportunity to deal with the issues to be solved by preparing the claims and being supported with the evidence and the reasons for the claims they have compiled. Thus, we formulated a hypothetical argumentation skill learning model which consist of phases: (1) orientation, (2) exploration, (3) pre-argument, (4) argument and contrast, and (5) reflection.

3.1.4. Provision of learning environment
In the development of the learning models, developers must think about the appropriate learning environment in order to achieve the learning objectives. As mentioned earlier in this article, the learning model is also aimed at developing students’ social skills. An appropriate learning model that can develop students’ social skills are learning models that belong to cooperative learning [7]. One of the shared-characteristics of cooperative learning models is that students work in heterogeneous groups. Thus, the skill-learning learning model in its implementation is managed by the learning environment in which students work in cooperative groups.

3.2. Validation results of the learning model
Expert validation of content validity and construct of argument learning model of argument was done through Focus Group Discussion (FGD) mechanism. There are three chemistry / science education experts who validate the model of arguing skill learning. The files used for validation in FGD activities are validation tools, student book, and lesson plan (one meeting). Validation results by the three validators were used as data to perform expert validation analysis.

3.2.1. Content validity
The validation was given by 3 experts on the contents of the learning model as summarized in table 1
### Table 1. Expert judgments on the learning model.

| No | Aspects             | Average score | Category |
|----|---------------------|---------------|----------|
| 1  | Rationality         | 4.12          | Valid    |
| 2  | Supporting theories | 4.25          | Very Valid |
| 3  | Learning environment | 4.00         | Valid    |

The calculation of percent of agreement obtained from those three validators which was specified as validator 1 & 2, validator 1 & 3, validator 2 & 3 on rational aspect, supporting theory, and learning environment shows a score of 75% which means it shows the inter-validator mutually agree on the assessment given.

#### 3.2.2. Construct validity

The construct validity is the expert's assessment of the consistency of the learning model. The consistency was assessed by experts regarding four aspects, namely 1) syntax of learning model of argumentation skill, 2) social system, 3) support system, and 4) instructional impact and herding. Each of these aspects is the embodiment of the consistency of the learning model of arguing skills must meet internal consistency and really describe what it is supposed to be. Expert assessment of the construct validity of the skill learning model argued in summary is presented in Table 2.

### Table 2. Expert judgement on the construct validity of the learning model.

| No | Aspects                      | Average score | Category   |
|----|------------------------------|---------------|------------|
| 1  | Syntax                       | 4.23          | Very Valid |
| 2  | Social system                | 4.67          | Very Valid |
| 3  | Supporting systems           | 4.17          | Valid      |
| 4  | Instructional and companion impact | 4.00    | Valid      |

The calculation of percent of agreement obtained from 3 validators are specified as validators 1 & 2, validators 1 & 3, validators 2 & 3 in the above four aspects indicate a score above 75%. This score shows the inter-validator mutually agree on the assessment given. Based on the data of Table 2 of the expert assessment of the validity of the construct, it is clear that there are two aspects considered in the category of ‘very valid’ and the other two aspects in category of ‘valid’. Thus, it can be justified that the developed learning model has fulfilled internal consistency and really illustrates what it should be.

### 4. Discussion and Conclusion

Based on the results of expert assessment as indicated in Table 1 and Table 2, it is important that the learning model declared as valid should meet the criteria of content validity and construct validity. This means that the validation results have fulfilled one of the feasibility criteria of a learning model as stated by Nieveen & Folmer [15] that the learning model is feasible as an educational research product if it has content validity and construct validity in a valid category.

In phase 2, that is exploration, students were asked to carry out activities of looking for evidence and determine evidence that can be used to strengthen claims through the activity of analyzing information from student books and experimenting. In this regard, Toulmin [8]; Dawson & Venville [5] argued that in order for the claim to be acceptable and undeniable, the claim must be supported by strong evidence. Evidence-seeking activities can be undertaken by applying open-ended inquiry [16]. Similarly, the findings of Acar [12] show that evidence-seeking activities can be done through inquiry learning to improve argumentation skills and science process skills. These results are reinforced by Wilson, Taylor, Kowalski and Carlson [17] who found that evidence-seeking activities can conducted with hands-on activity-based activities, that is, by reviewing teaching materials and conducting experiments conducted in groups to improve argumentation skills and science process skills.

In phase 3, namely argument and contra-argument, teachers help students to be able to communicate, respond to, and defend arguments consisting of claims, supporting evidence, the reasons that explain why it can be used to strengthen claims, and contra-argument, develop good language skills and
systematic thinking through using argument diagrams. It is also to help students in learning social interaction and mutual respect. Internalization is a process of deepening students’ argumentation skills and concept understanding that students have gained by repetition processes. According to the cognitive constructivist theory, that is the theory of the level of information processing; people handle stimuli at different levels of mental processing and will only retain the information that has been handled through the most earnest and profound processing [18].

In phase five, that is reflection, students carry out activities to reflect on the discussion process and the result of arranging the argument diagram. Students are required to submit conclusions on the outcomes of argument diagrams that have been discussed in previous activities and topics that have been studied. This is supported by Slavin [18] which states that praise referring to the clear performance of the gift is determined by student performance and of course a well-defined behavior. This is also relevant to the findings of Dawson & Venville [5] revealing that reflection is the last step in the learning of argument skills. The step of reflection is a last and important step in the learning of arguing skills to provide feedback on student work [4].

Acknowledgements
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