The Development of Hands-on Activities Learning for Improving Student Critical Thinking Skills

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Abstract- This study aims to develop Hands-on Activities learning that are integrated with critical thinking indicators through the student worksheets on the pressure subject. This type of research is Research and Development (R&D) using the 4D model covering the stages of define, design, develop, and disseminate. In this study only carried out to the develop stage. Data collection was carried out through validation assessment sheets of worksheet filled out by 3 validators. Aspects assessed include aspects of graphics and presentation, language, and content of worksheet. Data were analyzed descriptively to determine the results and validity values. The results of data analysis obtained from the validation assessment showed that all aspects received an average score in the range of 3.52 to 3.67 with a very high category. The worksheet of Hands-on Activities is declared valid, so it is eligible to be used as a learning media in an effort to improve students' critical thinking skills at school.

Keywords: Hands-on Activities; Critical Thinking Skills; Learning Media; Validation.

1. Introduction

A person's ability to succeed in determining is determined by his think's ability. There are many types of thinking skills, one of which is critical thinking skills. According to Hamzah (2008), critical thinking ability is a person's skill in using his thought process to analyze arguments and provide interpretations based on valid perceptions through logical reasoning, assumption analysis, and logical interpretation. Critical thinking is full and reflective thinking with an emphasis on making decisions about what to believe or do (Ennis, 2011). Critical thinking has a goal to prove and resolve something, equipped to solve problems (Facione, 2015).

But in reality, learning science that can foster critical thinking skills in students is still not in line with expectations. Many students still complain that science, especially physics is considered a difficult subject and is full of formulas. This is because due to the low activity during learning, teachers tend to give more lectures that only convey scientific concepts. As a result, students are less trained to develop their reasoning power in applying concepts that have been learned in real life so that students' critical thinking skills are not well developed (Yuliati et al., 2011).

Research conducted by Fithriyah et al. (2016) toward Junior High School students showed that the critical thinking ability of students is still relatively low. The results of this study are of the three questions tested, only one question can be answered correctly by students. The percentage of students who managed to answer one question correctly was only 26.92%. Research of Irawan et al. (2017) also showed the same results, namely the critical thinking ability of junior high school students is relatively low. The average percentage score of students from all aspects of critical thinking skills was tested only 44.87%.

To overcome the problems above, there need the efforts of various parties, especially the teachers. According to Akinoglu and Baykin (2015), the role of the teacher and the education process is very

important to improve students' critical thinking skills. Teachers can do a lot to encourage higher-order thinking skills levels of students (Chinedu and Kamin, 2015). Teacher innovation and creativity is needed in learning that can accustom students to critical thinking. Like choosing the right learning model with the material and students, so that activities in learning can be further improved and students' thinking abilities can develop properly. An educator is a subject dealing directly with students as an educational object that plays an important role in developing the potential and thinking skills of students (Yennita et al., 2018).

One way to improve student's critical thinking skills is to involve students in Hands-on Activities learning. Several studies have proven that the application of Hands-on Activities learning can improve students' thinking abilities (Ateş and Erylmaz, 2011; Hussain and Akhtar, 2013; Piergiovanni, 2014; Saido et al., 2015). In general, Hands-on Science Activities that involve activities that are participated by students to pass, be manipulated or accepted by the scientific process. Hands-on Science Activities are also effective experience-based learning (Hussain and Akhtar, 2013). Haury and Rillero (in Ateş and Erylmaz, 2011) also suggested that Hands-on Science Activities can be interpreted as learning that involves activities and direct interactions with natural phenomena or related education or understanding.

To have a pleasant learning process in the classroom, needed an innovation of learning material. One of the supporting materials used by teachers to support the learning process is student worksheets (Zulyadaini, 2017). Practice Learning Activities developed through student worksheets integrated with critical thinking indicators. So, through this worksheet is expected student's critical thinking can be improve.

2. Methodology

This type of research is Research and Development (R&D) using the 4D model covering the stages of define, design, develop, and disseminate. But in this study it was only done until develop stage. The define stage is a requirement to establish the criteria needed in the preparation of worksheet. At this stage an analysis of learning, students, assignments, and learning objectives is carried out. After obtaining the problem from the define stage, then the design stage done to complete the worksheet. In the design stage was selected Hands-on Activities learning media and worksheet format . Last is the stage of develop that aims to produce worksheet. Developing activities consist of validation carried out by team of experts. The results of the validation are used as revision material to produce a valid worksheet.

The instrument used in this study was the worksheet validation sheet which was used to obtain assessment data from the validator. The aspects consist of 7 items of graphic and presentation aspects, 3 items of language aspects, and 10 items of content aspects. The data analysis technique used in this study is descriptive statistics. The assessment category on the validation sheet aspect uses a Likert scale with scores: 4 for Strongly Agree, 3 for Agree, 2 for Disagree, and 1 for Strongly Disagree. The validation categories based on Likert scale can be seen in Table 1.

Table 1. Category of Validity

No	Average Score	Category
1	$3{,}25 \leq x \leq 4$	Very High
2	$2{,}5 \leq x < 3{,}25$	High
3	$1{,}75 \leq x < 2{,}5$	Low
4	$1 \leq x < 1{,}75$	Very Low

Each assessment indicator item is said to be valid if the average score range is in the high and very high categories. If any of the assessment indicators are in the low and very low categories, an improvement will be made to the indicator.

3. Result and Discussion

3.1. Define

In the first stage, an analysis of the needs for the development of Hands-on Activities learning to study the problems that exist in schools, so that from the finding of it can be made worksheet in accordance with the needs of students.

After observing in Junior High School, it was found that there were problems in science learning, that is students who were able to think analytically in learning were only about 10% in each class. Meanwhile, student who champion in the class cannot to answer the National Examination questions for category of analyze. In addition, students 'cognitive test results are higher, however students' participation and activeness in learning is still lacking.

Then, based on observations made by Sugianto et al. (2018) and Ningrum (2018) that learning activities that tend to be teacher centered result in passive and not independent student. Science learning that occurs only focuses on theory, so that it is separated from the application of concepts in everyday life. The results of observations in Ningrum's study (2018) also showed that students only listened and followed all the methods taught by the teacher. Students are less motivated to discuss the material presented by the teacher, so the learning experience of students in building their knowledge by thinking still needs to be improved.

Zulyadaini (2017) through his research observations also found that worksheet used in class by students only contained material and questions that were still monotonous, language that was difficult to understand, and without concept explanation, so students tend to memorize without understanding concepts. Analysis of the learning problems above indicates that students' critical thinking skills are still relatively low.

After knowing about science learning problems and students' learning attitudes at school, a task analysis study is conducted on the curriculum, syllabus, and material concepts that will be taught to formulate learning objectives.

3.2. Design

The media chosen to develop learning Hands-on Activities is worksheet integrated with critical thinking skills. The pressure subject consists of 10 hours of study divided into 4 worksheet. The design of worksheet Hands-on Activities is shown in Figure 1.

The worksheet is designed with a colorful display containing 5 activities hands-on, digging information, designing and conducting experiments, collecting data, analyzing, finding and building own knowledge. Every step in Hands-on Activities learning integrated with indicators of critical thinking skills.

3.2. Develop

After completing the design, worksheet is then developed by integrating indicators of critical thinking skills into the stages of learning Hands-on Activities. Cover and content of worksheet are shown in Figure 2. And the last stage of this research is the product validation stage. In the first validation stage, the validator provides suggestions for improvement as shown in Table 2

Table 2. Suggestion from the validator

No	Suggestion
1	Irrelevant images / icons are replaced or removed
2	Fix disproportionately illustrated experimental illustrations
3	The appearance of worksheet backgrounds is made plain (not pictorial)
4	Improve and add description of experimental illustration images
5	Provide enough space for students write answers
6	Improve and correct the writing in accordance with the rules of the Indonesian language
7	Give the conditions for the number of answers requested in question No. 4 Worksheet 4

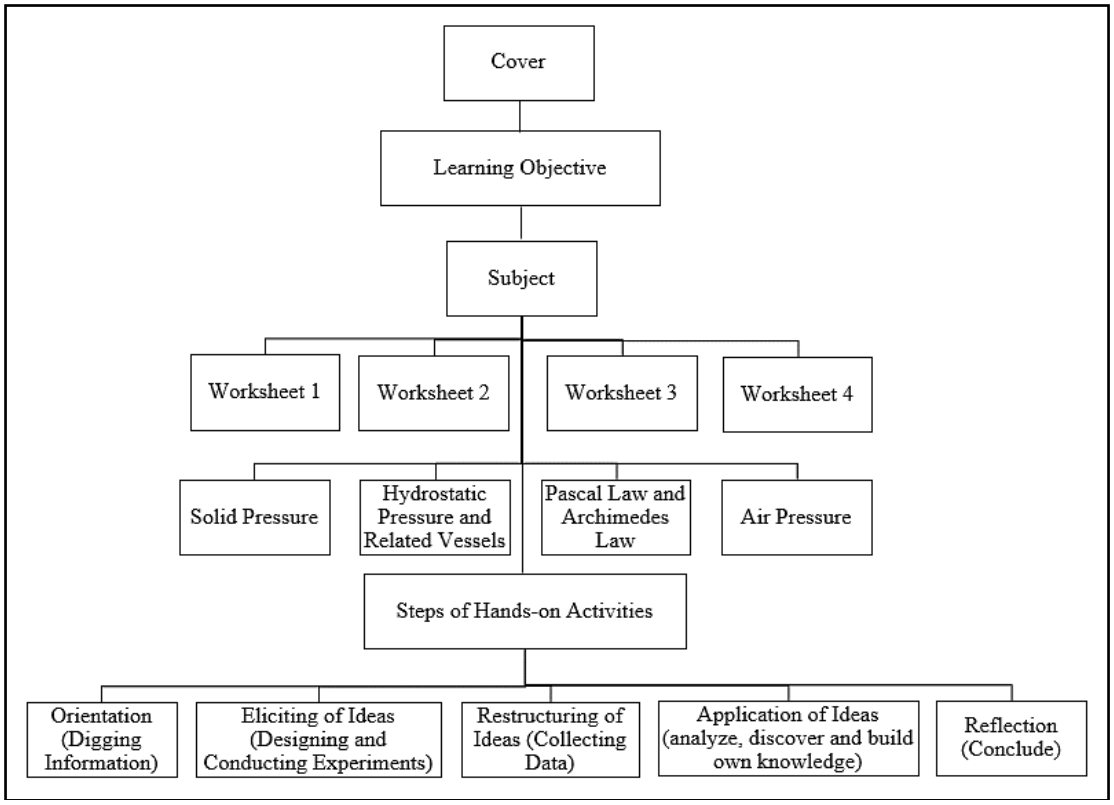

Figure 1. The design of the worksheet of Hands-on Activities Learning

Figure 2. Cover (left) and content of the Hands-on Activities worksheet (middle and right)

Suggestions from validators are used to repair and improve worksheet. After being corrected, the worksheet is given back to the validator for reassessment. The final results of worksheet validation for each aspect of graphics and presentation, language, and content are shown in Figure 3 below.

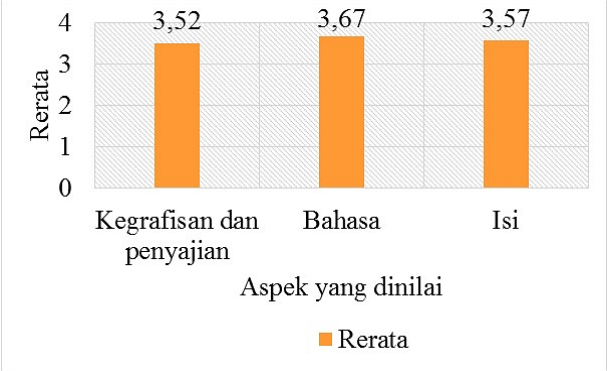

Figure 3. The result of worksheet validation

Figure 2 shows that the graphic and presentation aspects, language, and contents of the worksheet are valid. The average score obtained ranged from 3.52 to 3.67 with a very high category.

In the aspect of graphics and presentation, the validator assesses the design, layout, illustrations and drawings, the influence of the presentation of images and subjects on the motivation of students, as well as the completeness of worksheet information and instructions. While in the aspect of language, the validator assesses the suitability of writing in Indonesian, communicative rules, as well as the clarity and ease of understanding language. For indicators assessed on aspects of the contents of worksheet along with their validation results can be seen in Table 3 below.

Table 3. The Validation Results of Worksheet Contents Aspect

No	Aspects Validated	Mean	Category	Conclusion
1	The appropriate between goals and learning activities	4,0	Very high	Valid
2	The depth of subject according to student's level of thinking	3,7	Very high	Valid
3	Truth of concept	4,0	Very high	Valid
4	Through activities digging information* students are encouraged to provide simple explanations and build basic skills **	3,7	Very high	Valid
5	Through the activities of designing and conducting experiments* students are encouraged to build basic skills and conclude**	3,7	Very high	Valid
6	Through activity of collecting data* students are encouraged to build basic skills and conclude**	3,3	Very high	Valid
7	Through the activity of analyzing and building own knowledge* students are encouraged to conclude and provide further explanation**	3,0	High	Valid
8	Systematic concepts	4,0	Very high	Valid
9	The relationship of concept with daily life	3,3	Very high	Valid
10	Stimulate curiosity of students	3,0	High	Valid

*Hands-on Activities ; **Critical Thinking Indicators Group.

Based on the data in Table 3 it can be seen that this aspect of the content is valid, the average score is in the range of 3 to 4 with high and very high categories. These results indicate that worksheet Hands-on Activities have met the indicators of critical thinking skills and can be used to practice students' critical thinking skills.

Providing a Simple Explanation

This group of indicators consists of 3 indicators. The first indicator is to focus the question with sub-indicators identifying or formulating questions. According to Ennis (2011), the focus is one of the basic elements in critical thinking. To focus on problems, knowledge is needed. The more knowledge one has, the easier it is for someone to recognize information. The focus referred to in this indicator is the focus on the question or problem given.

The second indicator is analyzing arguments with sub-indicators identifying conclusions. Through analysis activities, students can identify logical steps that are used in the thought process to arrive at conclusions. Whereas the third indicator is asking and answering questions, with sub-indicators giving simple explanations and mentioning examples. Asking and answering questions is one of the characteristics of a critical thinker (Elizabeth Thyer, 2013).

Relevant to the results of research Saido et al. (2015) which says that one of the most effective learning to develop students higher-order thinking skills is learning that can activate students knowledge. Activating prior knowledge of students will help them to make connections between prior

knowledge and new information they learn. By utilizing what students already know through asking critical questions, teachers can support students in the learning process

Building Basic Skills

The indicator group consists of 1 indicator namely observing and considering the observation report with 3 sub-indicators, namely: (1) involving a little hypotesis; (2) reporting the results of observations; and (3) accountable for the results of observations. Ennis (2011) said that one of the skills that must be possessed by a critical thinker is the ability to observe. In making observations, it takes a high focus and accuracy of the observed object to get good observations.

Through worksheet Hands-on Activities, students are asked to observe pictures of experimental designs on worksheet, then the teacher asks students to report their observations on the tools and materials used in the experiment. In addition, after conducting experiments or demonstrations, the teacher gives questions that require students to take responsibility for the results of their observations (Gusmida & Islami, 2017).

The variety of activities and topics studied, provides an opportunity for students to be able to observe various problems through different activities and topics so that the ability to observe and consider student observation reports becomes more trained. This is supported by Saido et al. (2015) that one effective learning to develop students' higher order thinking skills is learning that uses a variety of class activities.

Conclude

Indicators the group conclude that consists of 2 indicators: (1) deducing and considering the results of deduction; and (2) induce and consider the results of induction. Ennis (2011) argued that the ability to deduce and induce a skill that should be owned by critical thinkers.

In Hands-on Activities worksheet, dissonance is given to students at the beginning of learning. Dissonance is a sense of discomfort or anxiety that is intended for unusual, strange, and as if a trick for students. But the discomfort and anxiety encourage students to think about what really happened. The dissonance created by the teacher can be in the form of information and demonstration of a simple experiment that is packaged in such a way that can attract the attention and curiosity of students so that students think why it can happen. This is supported by Moon (in Spiller and Ferguson, 2011) who say that creating a sense of discomfort or dissonance is a good stimulus for thinking.

Providing Further Explanation

The indicator group provides further explanations consist of 2 indicators: (1) defining the term and considering a definition; and (2) identifying assumptions. Ennis (2011) says that the skills of defining and assuming are skills that must be possessed by critical thinkers.

From a definition, someone can get new information that can be a clue to solve a problem. The ability to define a term is very important, because an incorrect definition will make the meaning of the definition incorrect. Therefore, consideration is needed in making and accepting a definition. Almost the same as the definition, an assumption will have an impact on a decision. For this reason, consideration and caution are needed in expressing and accepting an assumption.

4. Conclusion

Learning Hands-on Activities to improve students' critical thinking skills has been developed through the worksheet media. The worksheet is considered valid by a team of experts with a very high category for the average score of aspects of graphics and presentation, language, and content of

worksheet. From the results of data collection and analysis, the worksheet is ready to be used as a science learning media to improve students' critical thinking skills.

Acknowledgement

Thanks are presented to the Natural Science Education and Physics Education Study Program, Faculty of Teacher Education and Training, Riau University. Special thanks are also delivered to the validators and senior lecturers due to the suggestions in the developing of Hands-on Activities worksheet.

References

Akinoglu, O., and Baykin, Y., 2015, Raising Critical Thinkers: Critical Thinking Skills in Secondary Social Studies Curricula in Turkey, *The Anthropologist*, 20:3, 616-624.

Ateş, Ö., and Erylmaz, A., 2011, Effectiveness of hands-on and minds-on activities on students' achievement and attitude towards physics, *Asia-Pacific Forum on Science Learning and Teaching*, Volume 12, Issue 1, Article 6, p,1, Turkey.

Chinedu, C.C., and Kamin, Y., 2015, Strategies for Improving Higher Order Thinking Skills in Teaching and Learning of Design and Technology Education, *Journal of Technical Education and Training (JTET)*, Vol. 7, No.2, ISSN 2229-8932.

Elizabeth Thyer. 2013. *Critical Thinking*. Deakin University. Australia. (Online). http://www.deakin.edu.au (accessed 7th September 2019).

Ennis, Robert H., 2011, *The Nature of Critical Thinking: An Outline of Critical Thinking Disposition and Abilities*, University of Illinois, Amerika Serikat.

Facione, P.A., 2015, *Critical Thinking: What It Is and Why It Counts*, Insight Assessment, ISBN 13: 978-1-891557-07-1.

Fithriyah, I., Sa'dijah, C., dan Sisworo, 2016, Analisis Kemampuan Berpikir Kritis Siswa Kelas IX-D SMPN 17 Malang, *Prosiding Konferensi Nasional Penelitian Matematika dan Pembelajarannya (KNPMP I)*, ISSN: 2502-6526, Universitas Muhammadiyah Surakarta, Surakarta.

Gusmida, R. & Islami, N. (2017). The Development of Learning Media for the Kinetic Theory of Gases Using the ADDIE Model with Augmented Reality. *Journal of Educational Sciences*, 1(1), 1-10, ISSN: 2581-1657.

Hamzah, B. Uno., 2008, *Model Pembelajaran Menciptakan Proses Belajar Mengajar yang Kreatif*, Bumi Aksara, Jakarta.

Hussain, M., and Akhtar, M., 2013, Impact of Hands-on Activities on Student's Achievement in Science: An Experimental Evidence from Pakistan. *Middle-East Journal of Scientific Research*, ISSN: 1990-9233, IDOSI Publications, Pakistan.

Irawan, T.A., Rahardjo, S.B., dan Sarwanto, 2017, Analisis Kemampuan Berpikir Kritis Siswa Kelas VII-A SMP Negeri 1 Jaten, *Prosiding Seminar Nasional Pendidikan Sains (SNPS)*, Universitas Sebelas Maret, Surakarta.

Ningrum, I.E., 2018, Development of Student Worksheet Mathematic Based on Problem Based Learning (PBL), *International Summit on Science Technology and Humanity (ISETH)*, p-ISSN: 2477-3328, e-ISSN: 2615-1588.

Piergiovanni, P.R., 2014, Creating a Critical Thinker, *College Teaching*, 3, 86-93.

Saido, G.A.M., Siraj, Saedah., Nordin, A.B., and Omed, S.A., 2015, Teaching Strategies for Promoting Higher Order Thinking Skills: A Case of Secondary Science Teachers, *Malaysian Online Journal of Educational Management (MOJEM)*, Volume 3, Issue 4, 16-30, E-ISSN: 2289-4489, Malaysia.

Spiller, D., and Ferguson, P.B., 2011. *Teaching Strategies to Promote the Development of Students' Learning Skills*. Teaching Development Unit. The University of Waikato. Hamilton, New

Zeeland. (Online).http://www.waikato.ac.nz/tdu/pdf/booklets/14_TeachingStrategies.pdf (accessed 7th September 2019).

Sugianto, S.D., Ahied, M., Hadi, W.P., dan Wulandari, A.Y.R., 2018, Pengembangan Modul IPA Berbasis Proyek Terintegrasi STEM pada Materi Tekanan, *Journal of Natural Science Education Research*, Vol 1, No. 1.

Yennita, Khasyyatillah, I., Gibran, and Irianti, M., 2018, Development of worksheet based on high-order thinking skills to improve high-order thinking skills of the students, *Journal of Educational Sciences*, 2(1), 37-45, ISSN: 2581-1657.

Yuliati, D.I., Yulianti, D., dan Khanafiyah, S., 2011, Pembelajaran Fisika Berbasis Hands on Activities untuk Menumbuhkan Kemampuan Berpikir Kritis dan Meningkatkan Hasil Belajar Siswa SMP, *Jurnal Pendidikan Fisika Indonesia* ISSN: 1693-1246, Universitas Negeri Semarang, Semarang.

Zulyadaini, 2017, A Development of Students' Worksheet Based on Contextual Teaching and Learning, *IOSR Journal of Mathematics (IOSR-JM)*, Volume 13, Issue 1 Ver. III, PP 30-38, e-ISSN: 2278-5728, p-ISSN: 2319-765X.