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The Development of Integrated Science Learning Instrument Based on Project-Based Learning to Measure Critical Thinking Skills

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Abstract

Education has an important role in improving human resources. The indicator of the success of the learning process can be measured by the quality of the evaluation tool. This study aims to develop a measuring instrument for evaluating integrated science learning based on Project-Based Learning that is feasible to be used as one of the innovations in the development of learning assessment more operationally. This study integrates the 4D model with a non-test instrument development model. The population and subjects of this study were students of Madrasah Ibtidaiyah Teaching-Training Program of UIN Walisongo Semarang who took Basic Concept of Science lectures. The data of this study were obtained through (1) assessment based on the input of the learning evaluation experts, to determine the validity of the contents of the instrument; (2) results of the limited trial to determine instrument reliability. The data collection process uses instruments in the form of project assessment observation sheets to measure critical thinking skills. The Project Based Learning based learning assessment instrument developed is declared valid and reliable so that it is feasible and can be used to measure students' critical thinking skills.

Key words: integrated science learning instrument, critical thinking skill

1. Introduction

The 21st century education challenge requires the quality of graduates who have competitiveness. Rapid advances in information and technology provide many things such as convenience and also threats. Students, now, are expected to have competencies that are capable of processing information and evaluating information obtained. Every process of evaluating and making decisions in using the right information requires critical thinking skills (Potter, 2010). Critical thinking skills train students to be skeptical of information (Susilowati, 2017). Similar to Facione (2013) and Huitt (2011) stated that the ability to think critically influences a person in thinking, making decisions, and is an important means of achieving success in the 21st century.

Critical thinking skills can be implemented precisely in science learning because they are able to improve the ability of the students to be more logical, rational, careful, honest, efficient, and on target (Birgili 2015). Facione (2015) and Filsame (2008) stated that critical thinking skills require students to be active, give feedback, ask questions, make decisions, make maximum use of learning resources (Paul R, 2006).

One of the right learning to improve students' critical thinking skills is the implementation of science learning with project-based learning models. The aspect developed in this project-based learning is based on the learning experience of students who are required to work in real terms, as if they exist in the real world that can produce products realistically (Dawit T, 2013).

Evaluation and assessment activities will provide information on the success of project-based learning (Vidya, 2017). In fact, the assessment of science learning focuses on aspects of knowledge assessment only, while the assessment of attitudes and assessment of performance is not as expected, not least in universities. Hope that the assessment role can play a maximum role, it is necessary to form an authentic assessment. With authentic assessment students are required to perform tasks according to real-world needs and that is what will be able to develop students' abilities in knowledge, skills and attitudes (Gueldenzoph, 2008).

Basic Concepts of Science course in the Madrasah Ibtidaiyah Teaching-Training Program have their own characteristics in the form of methods, approaches, learning models and assignments. The form of assessment should certainly be different, especially with regard to the integrated Basic Concepts of Science learning that can strengthen students' critical thinking skills and the right form of project-based assignment (Yulianto, 2017). But these

conditions as far as the observations of researchers through observations do not yet exist and have not been fulfilled. Based on the facts and problems that exist, researchers are trying to develop an integrated Basic Concept of Science learning instrument based on project-based learning in measuring critical thinking skills of the students of students of Madrasah Ibtidaiyah Teaching-Training Program.

2. Methods

This type of research is research and development (R&D) by Sugiyono (2015). thing developed is an integrated science learning instrument based on project-based learning to measure the critical thinking skills of PGMI Program students.

This program was conducted in the 3rd semester of Madrasah Ibtidaiyah Teaching-Training Program of UIN Walisongo Semarang who have taken Basic Concept of Science course. Subjects in the study are (1) students as subjects for simulation and trial (class test), (2) 3 experts for validation of learning-based science-based learning instruments to measure thinking skills that have been made. The expert team as e-mail validators are validators who have benefits in terms of curriculum that provides input on construction, content and language. (3) 3 lecturers to test instrument readability.

This study uses a reference development model that integrates 4D with non-test instruments. The 4D steps include: define, design, develop and disseminate. Data collection techniques are interviews and non-tests. Interviews are used to obtain initial information with an interview sheet. Non-tests are used to validate the developed assessment instruments. The instrument used is an observation sheet in the form of developed project instruments. Data analysis techniques in this study are descriptive and quantitative content validation analysis, analysis of assessment instruments on the results of development that have been tested and analysis of observations of critical thinking skills outcome.

3. Results and Discussion

3.1. Development process of Non-Test Instrument

Non-test instruments developed in the form of statements in assessing critical thinking skills in lecturing activities.

3.1.1 Product Design

Product design is related to the design of skills assessment instruments. The initial step is the preparation of instrument specifications and assembly questions which were preceded by searching for information, analyzing needs, reviewing the literature, identifying assessment needs so that the development of new model evaluation tools is needed.

3.1.2 Determining ding the purpose

The purpose of the non-test instrument developed is to measure critical thinking skills based on Project based Learning. At this stage, the instrument form has been determined, namely the observation sheet and then determine the indicators selected from the aspect of critical thinking skills.

3.1.3 Arrange the Grid

Arranging the grid is done by looking at the components of the appropriate skill statement.

3.1.4 Writing the instruments

The writing of the instrument corresponds to the grid with considering the material aspects, construction and language used.

3.1.5 Determining the scale and scoring system

Instrument scale is used in instrument development. The scoring system conducted by the researcher is the acquisition of scores from the observations that have been available for each item of statement given by the observer.

3.1.6 Instrument Review

The instrument review was conducted by experts in the field of science studies. The expert provides an assessment and input in the field of substance, construction and language in the developed instruments.

3.1.7 Trial Test and Trial Test Analysis

The trial aims to determine the reliability of the instruments developed. Expert advice and input are used will be used as an instrument improvement.

3.1.8 Assembling Instruments, Measuring and Interpreting the Measurement Results

The proper statement items are then reassembled into a complete instrument form. Measurement to measure critical thinking skills. Interpretation of measurements based on criteria.

3.1.2 design validation

Design validation is done to determine the extent of the feasibility of an instrument product based on the input of the experts.

Table 1. Percentage of the Review Results of the all three Experts

No.	Assessment Aspect	Assessment of the validators	Ideal Score	Percentage	Criteria
1	Content	19	24	79.2 %	Valid
2	Construction	45	52	86.6 %	Very valid
3	Language	18	24	75.0 %	Valid
		Average		80.3 %	Very Valid

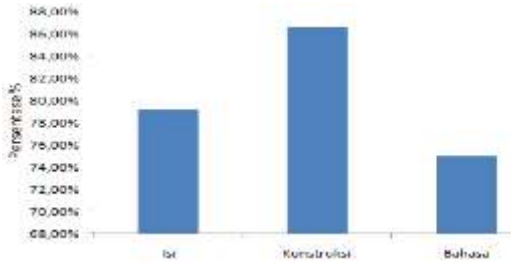

Figure 1. Diagram of the Percentage of the Experts Validation

The input, criticism and input from the Expert Team were then analyzed as follows: (1) the instrument ideally corresponds to learning achievement and expectation competency, (2) to improve the statements in accordance with good and true writing rules, (3) improve the operation of the appropriate language with statements that reveal the rules of critical thinking skills, (4) improve rubrics that are not on target, (5) fixing the statement that has multiple meanings, ideally the statement must be short, clear and precise, (6) revise the repetitive and unfocused statement in the disclosure of critical thinking skills, (7) does not lead to statements on certain judgments, (8) elements of practicality need to be prioritized, and (9) timing is also a part that must be considered in determining the number of statements.

The next stage was to test the small group in the third semester of the Madrasah Ibtidaiyah Teaching-Training Program. The chosen class is class 3A and the learning process conducted by one of the lecturers in the basic concepts of science. In the trial phase the validation was done by the lecturer in the form of questionnaire responses from the lecturer as the user of the instrument to assess students' critical thinking skills. The results of the percentage of lecturer responses are presented in Table 2 and Figure 2.

Table 2. Percentage of the results of the Lecturer's Response

No.	Assessment aspect	Assessment of the validators	Ideal score	Percentage	Criteria
1	Content	20	24	83,3 %	Very Valid
2	Construction	33	36	91,7 %	Very Valid
3	Language	17	20	85,0 %	Very
4	Proportion	22	24	87,5 %	Valid
5	Practicality	11	12	91,7 %	Very Valid Very Valid
		Average		87,8 %	Very Valid

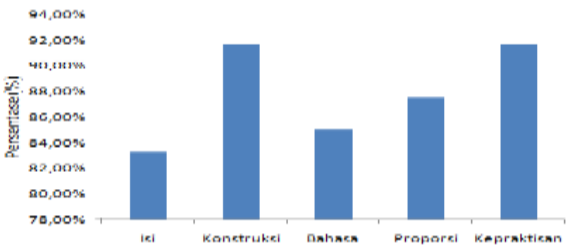

Figure 2. Diagram of the Percentage of Lecturer Responses

After going through product trials, the next process is to revise the assessment instrument based on the response of the lecturer.

Analysis of the level of validity that has been conducted by the researcher in the small group trials with the total of 41 respondents obtained rtable score of 0.30 with the results 3 statements (12%) declared invalid because the calculation results of rxy <0.30, while 21 statements (88%) were stated valid because rxy score > 0.30. Invalid statements include items number 4.18 and 23.

The results of the identification of the researcher on the items that are invalid, due to the poor quality of construction, grammar and sentence structure. The result data shows an integrated science learning assessment instrument based on project-based learning to measure students' critical thinking abilities of the students of Madrasah Ibtidaiyah Teaching-Training program is in good category, but there are some items that must be corrected and invalid statement items removed from the assessment instrument (Moon, 2005).

While the results of the reliability analysis carried out by researchers in the small group test produce a reliability index of rcount = 0.832

while rtable = 0.70. Because r11> rtable, it can be concluded that the science learning assessment instrument based on project-based learning to measure the critical thinking skills of Madrasah Ibtidaiyah Teaching-Training Program students is reliable. Reliability serves to find out how far the assessment tool can be trusted as a measuring tool that can describe the respondent's measured ability. The minimum reliability index limit is 0.700. If this index is smaller than 0.700, the error will exceed the limit, so the minimum instrument reliability index is 0.700.

Reliable instruments from limited testing are used to measure critical thinking skills of students who take classes on the basic concepts of science. The results of calculating the average aspects of critical thinking that appears in the lecture using Project-based Learning can be seen in Table 3.

Table 3. Average aspects of critical thinking skills in science lectures

Science Aspect Critical Thinking	Total Average score every meeting			Average	Category
	1	2	3		
Formulating the problem	2,9	3,1	3,3	3,10	Very good
Giving arguments	3,0	3,2	3,3	3,17	Very good
Making deduction	2,8	2,85	3,0	2,88	Good
Making induction	2,9	3,10	3,15	3,05	Very good
Performing evaluation	2,8	3,2	3,0	3,00	Good
Taking decisions and actions	2,7	3,2	3,25	3,05	Very good

While the measurement of critical thinking skills of all three lecture activities can be shown in Figure 3.

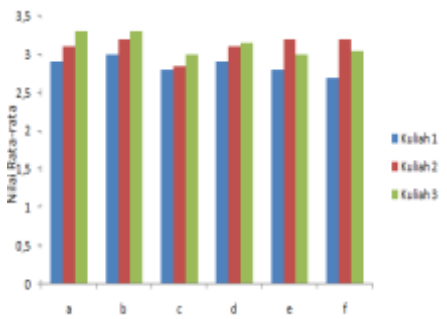

Figure 3. Aspects of Critical thinking skills

Note:
a) Formulating problems, b) giving arguments, c) making deductions, d) making inductions, e) evaluating, f) making decisions and actions.

Analysis of Table 3 and Figure 3 shows that project-based lectures familiarize students with learning to use critical thinking skills during lectures and the use of assessment instruments has increased significantly. Project based learning is able to improve student learning achievement (Setiyorini, 2011). While the factors causing the decline in the aspect of critical thinking skills of the students are due to lack of time in completing project assignments. This problem corresponds to research which reveals that assessment of project-based learning requires longer preparation and to disclose the ability of thinking requires a longer time (W Sumarni, 2016).

The effectiveness of the instrument model of learning that is integrated with Project based learning is based on the results of the responses of the lecturers to this instrument model. The attractiveness, easy to use, and usefulness of instrument products are some of the advantages of this instrument that has been tested in an integrated assessment of science learning, and declared effective and easy to use as a learning instrument for integrated science learning based on project-based learning to improve critical thinking skills.

The product is an authentic assessment model to measure students' critical thinking skills during the lecture process. The assessment process should be conducted in a real and direct manner periodically. Hosnan (2014:387) revealed that authentic assessment is a significant measure of revealing the three domains of science study.

The model of integrated science learning assessment instrument based on Project Based Learning is able to provide solutions for educators in conducting authentic assessments of students on aspects of skills that have so far been rarely done in the lecture process. This assessment instrument also triggers student activity and students' critical thinking skills during the lecture.

Based on the explanation above, this development objective produces a product in the form of an integrated learning instrument assessment model based on Project Based Learning to uncover critical thinking skills that have been achieved and can be used as an instrument that is very interesting, easy to use, useful in monitoring the progress of student skills achievement and this instrument can be said to be effective

4. Conclusion

Based on the results above, it can be concluded that this development research produced the final product in the form of science learning assessment instruments based on the project-based learning to measure critical thinking skills with very valid quality. This is based on the results of validation by three expert validators which show that this instrument has very valid criteria with an average percentage of 80.3%. In addition, based on the response of lecturers with very valid criteria with a percentage of 87.8%. As well as the final validity analysis of science learning assessment instruments based on project-based learning to measure critical thinking skills in small group trials, with the number of respondents 41 students with rtable 0.70 obtained 3 statement items (12%) that are invalid because rxy < 0.70, while 21 statement items (88%) are valid with rxy> 0.70. An invalid statement includes items number 4, 18, and 23. While the reliability analysis of the instrument produces a reliability index of rcount = 0.832 while rtable = 0.70. Because rcount > rtable, it can be concluded that an integrated science learning assessment instrument based on project-based learning to measure critical thinking skills is reliable.

5. References

Birgili B. (2015). *Creative and Critical Thinking Skills in Problem-based Learning Environments.* Journal of Gifted Education and Creativity, 2(2), 71-80 http://jgedc.org DOI: 10.18200/JGEDC.2015214253

Dawit T. Tiruneh, An Verburgh & Jan Elen, (2013). *Effectiveness of Critical Thinking In struction in Higher Education*: A Systematic Review of Intervention Studies. Higher Education Studies; Vol. 4, No. 1; 2014 ISSN 1925-4741 E-ISSN 1925-475X Published by Canadian Center of Science and Education

Facione PA. 2013. *Critical Thingking*: https://www.nyack.edu/files/CT_What_Why_2013.pdf

Gueldenzoph,Liza Snyder and Mark J. (2008). *Teaching Critical Thinking and Problem-Solving Skills*. The Delta Pi Epsilon Journal Volume 1, No.2, Spring/Summer.2008.

Huitt, W. (2011). *Bloom et al.'s taxonomy of the cognitive domain*. Educational Psychology Interactive. Retrieved from http://www.edpsycinteractive.org/topics/cognition/bloom.html [pdf] *(PDF) Learning Taxonomies, Critical Thinking*, Available from: https://www.researchgate.net/publication/312063575_Learning_Taxonomies_Critical_Thinking_and_Global_Issues_Content-Based_EFL [accessed Jul 20 2018].

Ismail K, Birsen. (*2016). The Investigation of the Effects of Authentic Assessment Approach on*

Mueller, J., (2005). *The authentic assessment toolbox*: Enhancing student learning through online faculty development. J. Online Learn. Teach., 1: 1-7. http://jolt.merlot.org/documents/vol1_no1_mueller_001.pdf

Paul R., & Elder, L. (2006). *the miniature guide to critical thinking*: Concepts and tools, 4. the Foundation for Critical thinking, Dillon Beach, CA. Retrieved Dec. 8, 2015, from http://www.criticalthinking.org/les/Concepts_Tools.pdf *(PDF) Learning Taxonomies, Critical Thinking*. Available from:

Potter, Mary Lane. (2010). *From Search to Research: Developing Critical Thinking Through Web Research Skill.* Microsoft Corporation. *Prospective Teachers' Problem-Solving Skills.* International Education Studies; Vol. 9, No. 8; 2016, ISSN 1913-9020 E-ISSN 1913-9039 Published by Canadian Center of Science and Education.

Setyorini, U., Sukiswo, S. E., & Subali, B. (2011). *Penerapan Model Problem Based Learning Untuk Meningkatkan Kemampuan Berpikir Kritis Siswa SMP*. Jurnal Pendidikan Fisika Indonesia, 7(1), 52-56.https://journal.unnes.ac.id/nju/index.php/JPFI/article/view/1070.

Sugiyono, A.2015. *Pengantar Evaluasi Pendidikan*. Rajawali Pers. Jakarta.

Vidya Putri S & Rosada D. (2017). *Pengembangan Penilaian Proyek Pembelajaran IPA Berbasis Discovery Learning untuk Mengukur Keterampilan Pemecahan Masalah*. Jurnal Inovasi Pendidikan IPA,3(1),2017.101-110. http://Journal .uny.ac.id/index.php/jipi.

Susilowati, Sajidan, Murni, (2017). *Analisis Keterampilan Berpikir Kritis Siswa Madrasah Aliyah Negeri di Kabupaten Magetan.* Prosiding Seminar Nasional Pendidikan Sains (SNPS) 2017.

Yulianto, A. Fatchan, Komang. (2017). *Penerapan Model Pembelajaran Project Based Learning Berbasis Lesson Study untuk Meningkatkan Keaktifan Belajar Siswa*. Jurnal Pendidikan: Teori, Penelitian, dan

Pengembangan Volume: 2 Nomor: 3 Bulan Maret Tahun 2017. Halaman: 448—453. http://journal.um.ac.id/index.php/jptpp/EISSN: 2502-471XDOAJ-SHERPA/RoMEO-Google Scholar-IP.

W. Sumarni, S Wardani, Sudarmin. (2016). *Project Based Learning to Improve Psychomotoric Skill*: A Classroom Action Research. Jurnal Pendidikan IPA. UNNES https:// journal.unnes.ac.id/ nju/ index.php/ jpii/ article/ view/4402/0.

Vidya Putri S & Rosada D. (2017). *Pengembangan Penilaian Proyek Pembelajaran IPA Berbasis Discovery Learning untuk Mengukur Keterampilan Pemecahan Masalah*. Jurnal Inovasi Pendidikan IPA,3(1),2017.101-110. http://Journal .uny.ac.id/index.php/jipi.