Higher order thinking skills: using e-portfolio in projectbased learning

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Abstract. The purpose of this research is to describe students' higher-order thinking skills through project-based learning using e-portfolio. The method used in this research is descriptive qualitative method. The research instruments used were test, unstructured interview, and documentation. Research subjects were students of mathematics, physics and biology education department who take the Basics Physics course. The result shows that through project-based learning using e-portfolio the students' ability to: analyze (medium category, N-Gain 0.67), evaluate (medium category, N-Gain 0.51), and create (medium Category, N-Gain 0.44) are improved.

1. Introduction

Thinking skill is one of the indicators of quality improvement of learning. In recent time, college learning is required to train students' higher-order thinking skills. Improving higher-level of thinking skills is a priority in science learning. One way to improve the higher-order thinking skills of prospective teachers is to design project-based learning. The lecture need to design the application of project-based learning with evaluation activities undertaken by students.

Evaluation or assessment is a learning activity that aims to build students' thinking and scientific attitudes. Through evaluation activities, students obtain data through classifying, processing, and searching for connectivity. The learning plan designed by lecturers, prioritized on instructing students to perform variety of activities such as: analysing data, categorizing, creating categories, summarizing, and predicting from discussion or practicum activities. Electronic portfolio is used to evaluate the students learning process during the project-based learning.

The E-portfolio of Project Based Learning provides an opportunity for students to analyze the literature from various references. Students conducted analysing activity when they receive essential questions and design projects provided by lecturers. E-portfolio using Project Based Learning model (PjBL) will be more visible in improving the ability of higher-level thinking. PjBL is a student-centred model integrated with real-world issues and activities, Educational Technology Division Ministry of Education [1]. This model also uses the project / activity [2] as the core of learning. In addition to the project / activity, the emphasis on problem finding is also an orientation of the PjBL model [3]. Projects in the PjBL model can be products, publications, or presentations [4]. PjBL can improve students' abstract thinking and gain understanding. In PjBL, students explore, make judgments, interpret, and synthesize information in meaningful ways [1].

E-portfolio Project Based Learning has the potential to increase Higher Order Thinking (HOT). E-portfolio model directs students to perform activities (1) analyze, (2) evaluate, and (3) make products.

The results of the series of activities allow students to think in higher level (higher order thinking skills). Students are required to reach higher-level thinking skills. Higher-level thinking includes reading ability with understanding and identifying needed and unneeded material. The ability to draw the correct conclusions from the data provided and to determine inconsistencies and contradictions in a group of data is part of higher-level thinking skills.

HOT is a process of thinking that not only memorizes, but also involves an in-depth understanding and critical analysis thinking process. Higher-order thinking is the ability to link, manipulate, and transform existing knowledge and experience to think critically and creatively in deciding and solving problems in new situations [5], including logic and reasoning, analysis, evaluation, creation, problem solving, and retrieval decision (judgment) [6]. Analysis is the ability of the individual to determine the parts of a problem and show the relationship between the sections, see the causes of an event or give arguments that underpin a statement [8]. Evaluation is the activity of making judgments with regard to the value of an idea, creation, and method [9, 10]. Creative ability is the ability to combine elements to form a new and unique structure, designing ways, and finding multiple answers [6]. This reasoning ability is necessary in the process of thinking and drawing a conclusion in the form of knowledge.

Higher-order thinking uses complex, non-algorithmic thinking to solve an unpredictable problem, using different approaches to existing tasks or exercise samples [9]. One of the indicators for measuring higher-order thinking includes analytical skills [10], one of the highest cognitive domain is the analytical ability [13]. Analysis is an attempt to sort out an integrity into elements or parts to clear the hierarchy or composition. The process of analysis requires the identification of component and connections between parts, so the output of this learning process represents higher-order thinking, as it requires an understanding of the content and structure of the material studied [3].

Indicators for measuring analytical skills include focusing on key ideas, analyzing arguments, and comparing and contrasting [6]. Indicators for measuring the ability of evaluation is the ability to make decisions or methods to be in line with the desired goals. Indicators for measuring creative ability are solving problems with more than one solution, designing a way to solve problems, and making something new. Indicators of logic and reasoning abilities are content, reasoning and evidence, as well as clarity of language styles. This research is conducted to know HOT of prospective science teachers through E- portfolio Project-Based Learning.

2. Methods

The method used in this research is one single pretest posttest design. Research subjects were students of mathematics, physics and biology education department who take the basics Physics course in Faculty of Education of Universitas PGRI Madiun. The data of HOT are obtained through tests (references), unstructured interviews and documentation. Data analysis techniques were based on Miles and Huberman in [13], data reduction, data presentation and conclusions.

3. Result and Discussion

The results of portable learning project implementation are described in Figure 1 below.

The picture above shows that there is an improvement in students' higher-order thinking skills. Cognitive level of analyzing (C4), evaluating (C5), and creating (C6) reflect Students' higher-order thinking skills. The Gain Values described in the following table reflect the improvement of students' higher-level thinking skills.

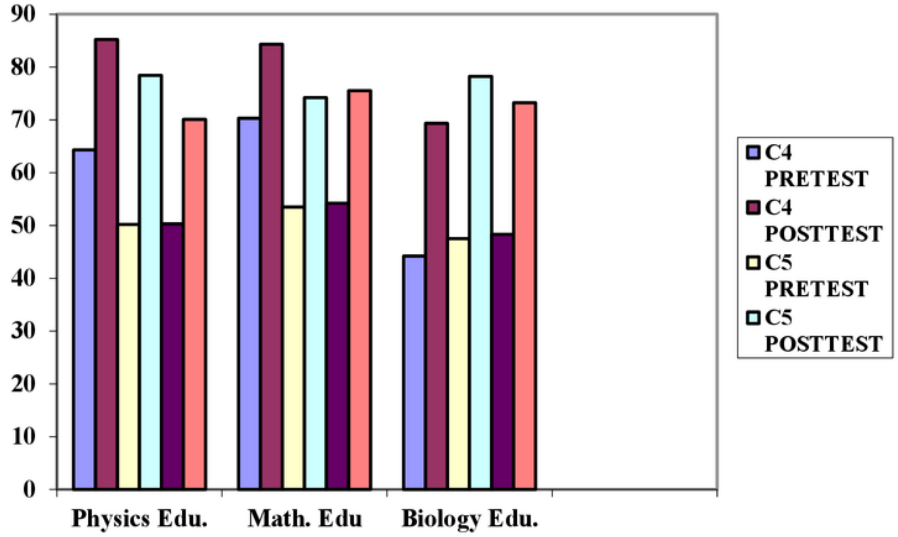

Figure 1. The value of the implementation of e-portfolio on project based learning

Table 1. Gain value of C4, C5, and C6 students

Students	C4 Pretest	C4 Posttest	Ngain	C5 Pretest	C5 Posttest	Ngain	C6 Pretest	C6 Posttest	Ngain
Physic Education	64.3	85.2	0.59	50.2	78.4	0.57	50.3	70.1	0.40
Mathematics Education	70.3	84.3	0.47	53.5	74.2	0.45	54.2	75.5	0.46
Biology Education	44.2	69.3	0.45	47.5	78.2	0.58	48.3	73.2	0.48

The results of these improvements prove that E-portfolio using Project Base Learning (PjBL) model can improve the ability of higher-level thinking (Table 1). Through the E-portfolio of Project Base Learning, students analyze the literature from various references. Students conduct analyzing activity when they receive essential questions and design projects provided by lecturers. PjBL can improve students' abstract thinking and explore students' understanding. This is in line with [1], the student explores, makes judgments, interprets, and synthesizes information in a meaningful way. To see higher-level thinking skills in evaluating, (C5) look at the following given problem.

3.1. Evaluating Problem C5 [14]

The experimental results provide black dot data on the tape as a ticker timer interpretation (Figure 2).

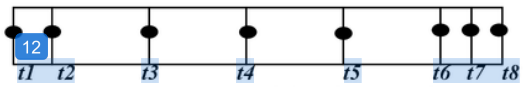

Figure 2. Ticker timer result

Based on that interpretation, it can be concluded that the velocity of a constant object, agree with that statement, explain your argument!, otherwise describe the correct statement and give your argument!

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……
……

3.2. The correct Responses of Student

Agreed, provided that the data is eliminated. By eliminating the data t1, t2, t7, and t8 it can be said that the velocity of the object has a constant velocity. Agreed, using only data t6, t7, t8 or t2, t3, t4, t5, t6 then the object moves with constant speed.

Disagree, because the distance point t1 to t2 is not equal to t3 and t4 so that the object changes speed (Figure 3 and Figure 4).

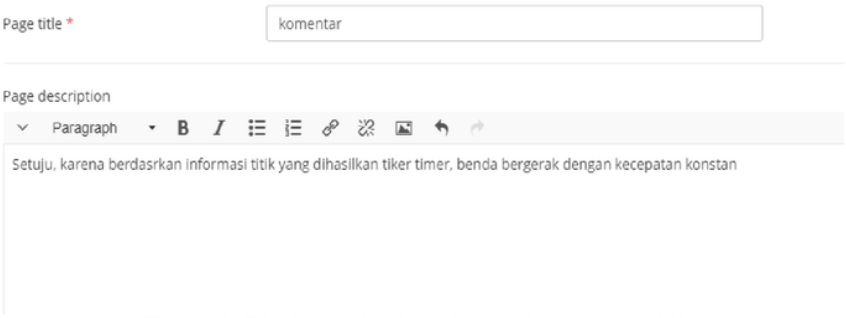

Figure 3. Display evaluation of 1st student in e-portfolio

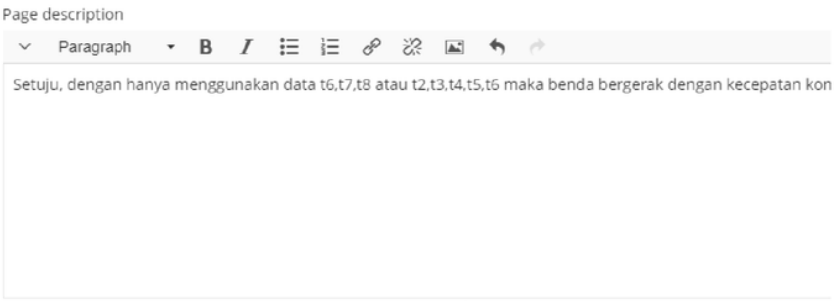

Figure 4. Display evaluation of 2nd student in e-portfolio

However, there are also students with the wrong response as follows.

3.3. Wrong Responses of Student

Agreed, because based on point information generated timer ticker, moving objects with constant speed.

Disagree, because the object performs a straight-line motion. The dot point is changing (Figure 5).

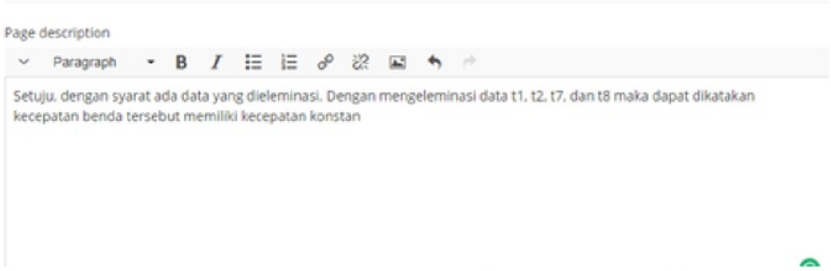

Figure 5. Display evaluation of 3rd student in e-portfolio

The use of creative issue supports the development of project-based learning using e-portfolio. This is in accordance with the results of the study [14] which states that the development of teaching materials using open questions can effectively improve the students' HOT. The activity of making motion experiments with constant acceleration manifests Higher creativity thinking skills (C6) as shown in Figure 6.

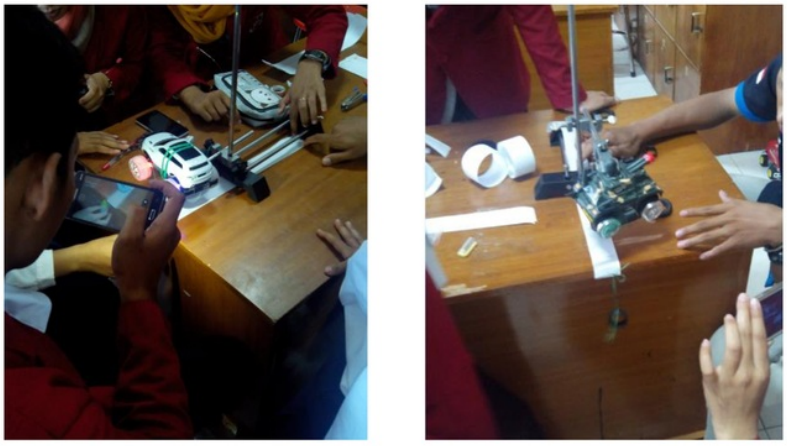

Figure 6. Documentation of creating activities uploaded in the e-portfolio

Through E-Portfolio Project Based Learning, students design and plan projects to improve students' higher-level thinking ability. In designing the project, students continue to conduct literature review to collect project information. Analytical activities are conducted through discussion among students. In preparing the schedule of activities, students must plan every stage of the project very well. The suitability of planning with the project is one indicator of students having good analytical and evaluation capability. In addition, evaluating activities are undertaken through project appraisal. Each student group presents its project products and other groups and lecturers conduct project reviews. The results of this study are in line with [15]. The creation of a technology-enriched classroom environment appears to have had a positive effect on the student acquisition of higher-order thinking skills. Technology development gives a positive effect on the development of students' creative thinking skill.

E-portfolios can administrate tasks and learning process of the students so that student conceptions can be profiled accurately based on their responses and tasks. By using e-portfolio students can respond freely and not too anxious to answer every task. For students who do not have good verbal

skills, written comments they made, express their opinion. Thus, the interaction between virtual students and students with lecturers can run more effectively.

The disadvantage of using e-portfolio is the inability to observe the expression of the students when responding to comments. The students' response does not show whether it is truly the independent conception of the students or based on the help from their friends. The use of e-portfolio should be added with emotion icon to know the expression of the student in answer including their feeling while doing and answering the problem. Each student's expression in responding can give information of student's interest to the learning. To avoid students from helping one another in giving response, the lecturer must provide more frequent response so that the consistency of the student's response can be used as one indicator of students' concerned

4. Conclusion

Project-based learning using e-portfolios can improve higher-level thinking skills, namely, analytical skills increase in the medium category (N-Gain 0.67), evaluation ability increases in medium category (N-Gain 0.51), and creative ability increases at Medium category (N-Gain 0.44). One way to improve the higher-level thinking skills of prospective teachers is to designing project-based learning. Evaluation activities undertaken by students through e-portfolio designed the implementation of project-based learning

References

[1] ETDME Malaysia 2006 *Project-Based Learning Handbook Educating the Millennial Learner* (Educational Technology Division Ministry of Education, Malaysia)
[2] Enke J, Tisch M, Metternich J, 2016 Learning Factory Requirements Analysis-Requirements of Learning Factory Stakeholders on Learning Factories *Procedia CIRP* **55** 224
[3] Musa F, Mufti N, Latif R A and Amin M M 2011 Project-based Learning: Promoting Meaningful Language Learning for Workplace Skills *Procedia Social and Behavioral Sciences* **18** 187
[4] Mubuuke A G, Louw A J N and Schalkwyk S V 2017 Cognitive and Social Factors Influencing Sudents' Response and Utilization of Facilitator Feedback in a Problem Based Learning Context *Health Proffessions Educations* 3 85
[5] Patton A and Robin J 2012 *Work That Matters: the Teacher's Guide to Project Based Learning* (United Kingdom: Paul Hamlyn Foundation)
[6] Rofiah E, Aminah N S and Ekawati E Y 2013 *Jurnal Pendidikan Fisika* **2** 17
[7] Brookhart S M 2010 *How to assess higher order thinking skills in your classroom* (Alexandria: ASCD)
[8] Kou F, Du J He Y and Ye 2016 Social Network Search Based on Semantic Analysis and Learning *CAAI Transactions on Intelegence Technology 1*: 293
[9] Omar N, Haris S, Hassan R, Arshad H, Rahmat M, Zainal N F A and Zulkifli R 2012 Automated analysis of exam questions according to bloom's taxonomy *Procedia - Social and Behavioral Sciences* **59** 297
[10] Asshaari I, Othman H, Bahaludin H, Ismail N A, Nopiah Z M 2012 Appraisal on Bloom's Separation in Final Examination Question of Engineering Mathematics Courses using Rasch Measurement Model *Procedia - Social and Behavioral Sciences* **60** 172
[11] Thompson T 2008 *International Electronic Journal of Mathematics Education* **3** 96
[12] Krathwohl D R 2002 *A Revision of Bloom's Taxonomy: an overview Theory Into Practice* **4** 212
[13] Branney J, Priego-Hernández J A 2018 *Nurse Educ Today [Internet] Elsevier* **61** 127
[14] Apino E and Retnawati H 2017 *J Phys Conf Ser* **812** 1
[15] Hopson M H, Simms R L and Knezek G A 2001 *Journal of Research on Technology in Education* **43** 109

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