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by Hestiningtyas Yuli Pratiwi

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Developing Formative e-Assessment as a Stimulus to Improve the Quality of Mathematical Methods for Physics Learning Process

Developing Formative e-Assessment as a Stimulus to Improve the Quality of Mathematical Methods for Physics Learning Process

H Y Pratiwi[1*], H D Ayu[1], Sujito[2], and N A Lestari[3]

[1]Physics Education Major, Faculty of Science and Technology, Universitas Kanjuruhan Malang
Jl. S. Supriyadi No.48, Malang 65148, Indonesia
[2]Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Malang
Jl. Semarang No. 5, Malang 65141, Indonesia
[3]Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya
Jl. Ketintang Gd C3 Lt 1, Surabaya 60231, Indonesia

*Email: hesti@unikama.ac.id

Abstract. Assessment is an important component of learning, one of the factors that affects quality and learning outcomes is the quality of the assessment held in the learning process. Innovation that can be done to support assessment formative is to utilize Information and Communication Technologies (ICT). The aim of the research is to develop the formative e-assessment model, identify the needs of development and guidance to implement formative e-assessment model, arrange the model and guidance of formative e-assessment, and find out the beneficial of formative e-assessment towards mathematical method of physics learning. The development design used refers to the Research and Development Design of Borg & Gall which has been modified. The design consists of four phases; they are introduction study, model design, model developing, and model validation. The research involved several universities in East Java. The results gained from the validators of material expert were 3.32 and validator of media expert was 3.10; while the result of limited experiment was 3.27 and it was classified as good category.

1. Introduction

The course of mathematical method for physics is the point of physics, that equip students with mathematical analysis devices needed to understand and solve problems related to the phenomenon of physics in nature, during the study monotonous mathematical method for physics using conventional methods and implementing summative assessment, weakness of conventional methods and summative assessment is the student difficulty to perform self-assessment, so as to know whether a concept that they understand takes a long time. This is in accordance with previous research stating that there are internal and external factors that cause students to have difficulty learning, internal factors are lack of interest and motivation to learn students, while the external factor is lack of media variations and learning methods [1]. Therefore teachers are required to have a good basic ability to create a quality

learning climate, start preparing planning until the method of assessment [2]. Assessment is an important component of learning. Teachers are able to know their students' thought using the assessment to understand the students' needs. Assessment is also used to find out the learning effectiveness implemented by teachers. The learning quality can be seen by the result of assessment [3]. Besides, Lambert stated that assessment implemented in learning can help teachers and students to find out the learning effectiveness and the students' achievements. Through assessment, teachers get information about the students' advantage and disadvantage in understanding the lesson. The information can be a foundation for teachers to determine which follow-up will be conducted to improve the learning effectiveness and to help students in learning [4].

Assessment used to help students learning is the formative assessment. Formative assessment focuses on assessment towards the learning process. Next, formative assessment focuses on feedback to identify the students' learning difficulty [5]. Formative assessment not only focuses on the students' final score, but also evaluates the students' improvement during learning process. The implementation of formative assessment in class can create conducive situation [6]. Problems occur in today's learning both in schools and universities are because the assessment which gives direct feedback towards the students' learning improvement which is known as formative assessment is rarely carried out [7], [8]. Today the implementation of learning assessment is dominated more by summative assessment than by formative assessment, but formative assessment is proven to be more effective by than summative assessment [9]. One of some obstacles happens when lecturers implement formative assessment is a large number of students that the lecturers need long time to check every student's work. It causes the lecturers need longer time to implement formative assessment. This problem has been proven by the often too late giving feedback.

Feedbacks are often given in wrong and late time. The results of learning implementing observation and the problems which often occurs in implementing learning are 1) there is still no effective assessment model as a role model, especially related to the implementation of Indonesian Qualification Framework; 2) lecturers do not have comprehensive data record about the students' activities; 3) there is limited interaction time for students and lecturers in learning process; 4) there is still no facility for students and lecturers to get learning source which is relevant to the subjects; 5) there is still unavailable ICT basis learning media in campus environment to enrich the students' concept about applying the implementation of website basis assessment. The solution for these problems is developing formative e-assessment model as new alternative to give assessment in learning process. The implementation of formative assessment which requires real time feedback giving is difficult to implement by lecturers without the support of adequate instrument and technology [10], [11], [12]. Besides, to solve the lecturers' difficulty in implementing formative assessment, it develops formative e-assessment model or formative assessment which uses the Information and Communication Technology (ICT). The result research stated that online web can increase the students' actively participation in lecture [6], [13]. According to Triantafillou assessment using ICT on Mobile Device can facilitate students to learn anytime and anywhere [14]. The development of formative assessment model assisted by computer helps teachers analyze formative assessment and give feedbacks to students more effectively and efficiently [15], [16], [17], [18].

Website assisted learning especially in implementing assessment will give significant impact towards the improvement of learning quality so that it can increase the students' achievements [19]. The implementation of the learning at least will give impact towards 1) easier learning implementation; 2) students have more source; 3) learning management conducted by lecturers becomes more effective and regular; 4) time to conduct discussion becomes more flexible and can be conducted anytime; 5) the availability of the prototype of developing assessment model for the learning which can increase the students' achievements. This research focuses on developing technology-based formative assessment by utilizing Moodle applications. Moodle is chosen because it can be used by anyone open source. By using Moodle we can build a system with the concept of E-Learning or Distance Learning. Various forms of learning materials to the assessment can be included in this Moodle application).

Methods

Research design used refers to Research and Development design (R & D Design) by Borg & Gall which has been modified. The design includes four (4) phases; they are 1) introduction study, which covers literature study and field survey; 2) model design; 3) model developing, which covers the assessment of model draft, model experiment, and model finalization; and 4) model validation. Introduction study was conducted in the beginning of the research using questionnaire and interview. The phase of model design began by identifying the needs of formative e-assessment model development and guide. Then, the research instrument was tested and validated on limited research subjects. Design implemented on development research includes analysis of needs and model design, development of model prototype, validation, and model revision. The research was conducted in some universities in East Java. The prototype of formative e-assessment model was validated by two material experts and two media experts. The experiment which was conducted by 6 lecturers who teach mathematical method of physics was limited to test the advisability of the model. The experiment was tested to 30 students.

The instrument to collect data was the questionnaire of the advisability towards formative e-assessment model. The expert validators give e-assessment model related to the accuracy, the usage, and the implementation. Data of model advisability was gained not only from lecturers and students, but also from the questionnaires. Lecturers gave assessment towards the model implementation and the developed guide, while students were also given questionnaire related to the system and instrument in e-formative assessment model. Data analysis gained by the research activity was descriptively and qualifiedly analyzed. The technique of descriptive analysis was used to determine the advisability of the developed model. The qualitative technique was used to explain the things need to be revised from the developed formative e-assessment model. The criteria of product advisability can be determined by determining the highest score range and then divide it by the number of criteria so it gets 0.75. Thus, determining the criteria of product advisability was conducted by adding the lowest score with the range division gained. Based on the average score gained then it determines the advisability on the validation of the developed product.

3. Results and Discussion

3.1. Preliminary Study

Before developing formative e-assessment model, the researchers conducted an introduction study. The first phase of the research included the study of mathematical method of physics subject and collecting data of lecture implementation. Study of mathematical method of physics 1 shows that the subject is compulsory for students of physics education major in one of the universities in Malang. The subject aims the students to have skill in formulating various physical processes into mathematical statements and being able to solve them analytically. Subject of mathematical method of physics develops students' skill in quantitatively analytical thinking based on intellectual pattern of logical mathematics in solving every physics problem. Mathematical method of physics is also the sequel of calculus.

Introduction study towards mathematical method of physics learning system which includes various problems which faced by lecturers and students in implementing learning process. Data collecting was also conducted by using questionnaire. The main data source is students who take mathematical method of physics in the even semester 3. Based on this method, the researchers found out the condition of the lecture and the possibility to implement the formative e-assessment model.

The analysis result shows that 76.52% respondents stated agree to be given learning sources on the internet, 18.98% respondents stated very Agree, and the rest 4,5% stated disagree. The reasons of respondents who disagree and very disagree have difficulty in accessing the internet; they want certainty which they can get only from the lectures; and that think they do not have adequate facility. Respondents who stated the agreement (agree and very Agree) towards the necessity of showing learning source on the internet have argumentations of 1) feeling helped by having additional material when they study at home; 2) easily accessing the web can accelerate and facilitate them in gaining

lecture materials; 3) giving training about using technology skill; 4) becoming more active, creative, and innovative and being able to think positively; 5) increasing concepts because of many lecture references; 6) having valid lecture references which focuses on the theme of the material; 7) feeling independent in gaining information; and 8) having more qualified, more interesting, and more fun learning.

Assessment about feedback from lecturers, students have various opinions about the necessity of feedback when lecturers give exercises, assignments, and tests. As many as 65.4% students who became respondents stated very agree to have feedback from lecturers and 27.9% students stated Agree. Their reasons for giving agreement (very agree and agree) towards the lecturers' feedback are 1) as evaluation to find out the advantages and disadvantages; 2) as material to improve the assignments or other exercises; 3) quickly find out the result of study; 4) as learning motivation; and 5) use to measure the skill in joining the lecture. It fits to the result of the previous research that stated quick feedback can help students to understand the concept quickly and can help teachers to find the students' problems so they can be quickly solved [20]. As many as 6.7% respondents stated disagree because the assessment which is given by lecturers is not objective and takes much time, and there is inadequate facility. Some other findings show that students need more time to interact with lecturers outside the lectures. As many as 92.48% respondents gave their agreement towards the implementation of learning model and online basis assessment in lectures. As many as 5.2% respondents gave disagreement without giving reasons.

In this phase of introduction study the researchers also studied online basis lecture models conducted by the previous researchers. The result of the previous study showed 1) the developed model has not used feature to implement the learning assessment; 2) the available model was developed by using material on the internet to motivate the students in preparing themselves; 3) there was pre-test related to the material which would be discussed; 4) the internet assisted lecture material was supposed to enrich the lecture material; and 5) the assessment was very rarely implemented in online lecture model.

3.2. The Specification of E-Formative Assessment Prototype

This product is arranged using the assistance of Moodle 3.1. program which is designed to have various facilities of resources and activities. The developed Resource includes introduction, module of lecture, power point for every sub-material, and their additional sources. While the developed activities which is adapted to the aim of the research includes the assignments which contains enrichment assignments; chat which functions as mean of communication among students, and between student and lecturer; forum which is used for students to discuss the material which is considered to be difficult with the lecturers; quiz which contains problems for every sub-material in various forms of problems. The descriptions of the development result are as follow:

3.2.1. Login Display. Program of Moodle application provides two login facilities; first as the admin or the lecturer and second as the user or the student. Once entering online lecture room with http://kuliah.elearningku.com/ browser, the first display is as Figure 1.

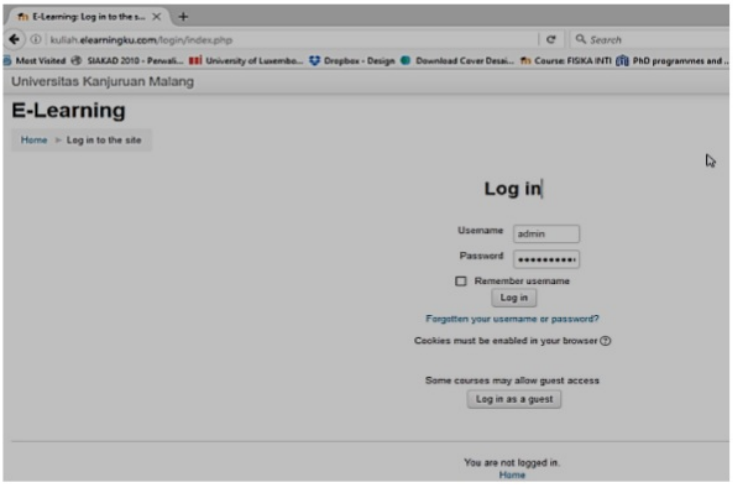

Figure 1. Login as Admin and as User

3.2.2. Front Display. The front display contains description of subject which contains purpose of lecture and kind of description will be learned during lecture process.

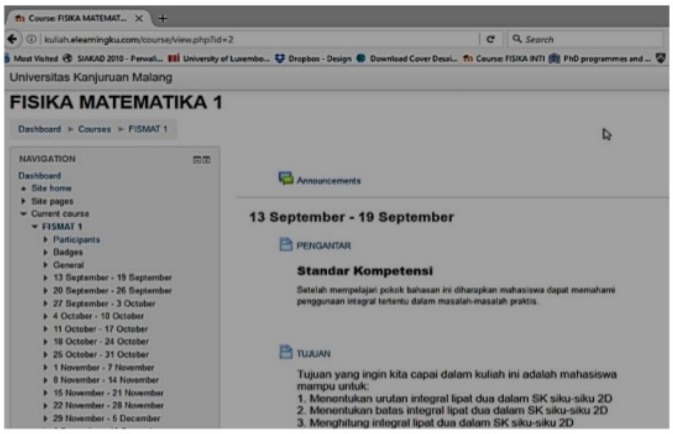

Figure 2. Display after *login*

3.2.3. Examination Display. Examination display is suggested to describe the assessment model which will be conducted and the information of assessment, the developed display is as on Figure 3 and Figure 4.

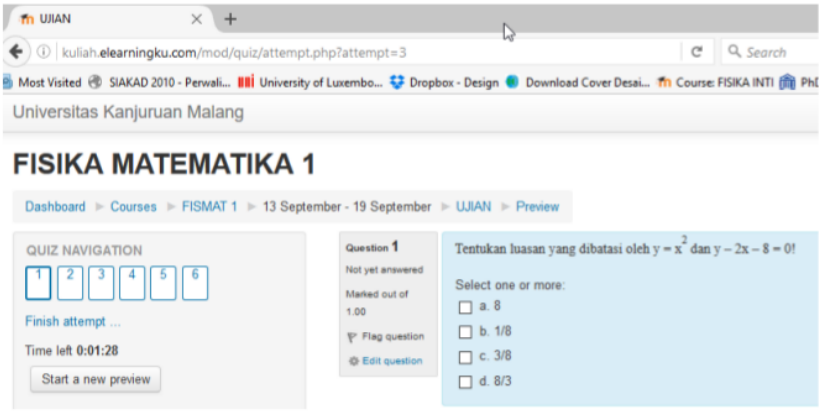

Figure 3. One of assessment model example

The description about examination and one of the assessment model example which is developed using Moodle ver.3.1. Online assessment uses limited time. The displayed problems are randomly shown to avoid the students' cheating.

3.2.4. Giving Final Assignment Model. Individual project is given to students using online model as the following display.

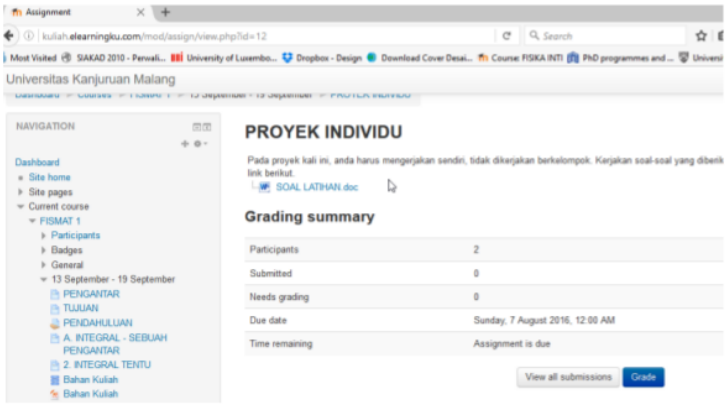

Figure 4. Final Assignment Project

3.3. The Description of Product Experiment Process

The process of product experiment includes expertise experiment and limited experiment. Expertise experiment is conducted to validate the product. It is given by four lecturers of some universities in Malang. Limited experiment is conducted to find out the reaction and the usefulness of formative e-assessment. It is conducted towards lecturers who have supported mathematical method of physics subject and students who are taking mathematical method of physics subject.

3.3.1. Material Validation. Based on the average validation result which received good criteria. Thus, the whole formative e-assessment can support the improvement of the students' achievement in the

lesson of multiple integral. The difference of average score in each aspect of formative e-assessment validation result is presented in Table 1.

Table 1. Result of Material Validation

Evaluated Aspect	Criteria	Explanation
Advisability of Learning Material	3.10	Adequate (Need Several Revision)
Advisability of Evaluation	3.50	Good (No Revision Needed)
Advisability as *Online* Learning Support	3.30	Good (No Revision Needed)
Advisability as Support to Improve the Achievement	3.40	Good (No Revision Needed)
Average	3.32	Good (No Revision Needed)

The whole result of formative e-assessment material validation on Multiple Integral is 3.32; it is classified as good criteria. The whole formative e-assessment of material substance and learning has met the good criteria as online learning supporting worksheet.

3.3.2. Media Validation. The data analysis of media validation result is obtained from the assessment result given by the validators. Data gained is quantitative data and qualitative data. The evaluated aspects are efficiency, learnability, memorability, effectiveness, and subjective satisfaction. The researchers then analyzed the quantitative data gained from the validation result. The researchers used method of average. The result of assessment gained was counted to have the average score in every aspect. The average of validation result then categorized into level of product advisability with the criteria as presented in Table 2.

Table 2. Result of Media Validation

Evaluated Aspect	Criteria	Explanation
Efficiency	3.35	Good (No Revision Needed)
Learnability	3.12	Adequate (Need Several Revision)
Memorability	3.05	Adequate (Need Several Revision)
Effectiveness	3.00	Adequate (Need Several Revision)
Subjective Satisfaction	3.00	Adequate (Need Several Revision)
Average	3.10	Adequate (Need Several Revision)

3.3.3. Limited Experiment. Small-scale trials are conducted against students taking mathematics physics 1 in odd semesters. The consideration used is material, the students have already taken the course of calculus so that it is not too difficult; the computer facilities is not a constraint, because students already have laptops and internet network side, do not become an obstacle because the Internet network is provided by the university. Experiment was conducted towards 30 respondents of students and 6 respondents of lecturers Limited experiment results can be seen on the figure 5.

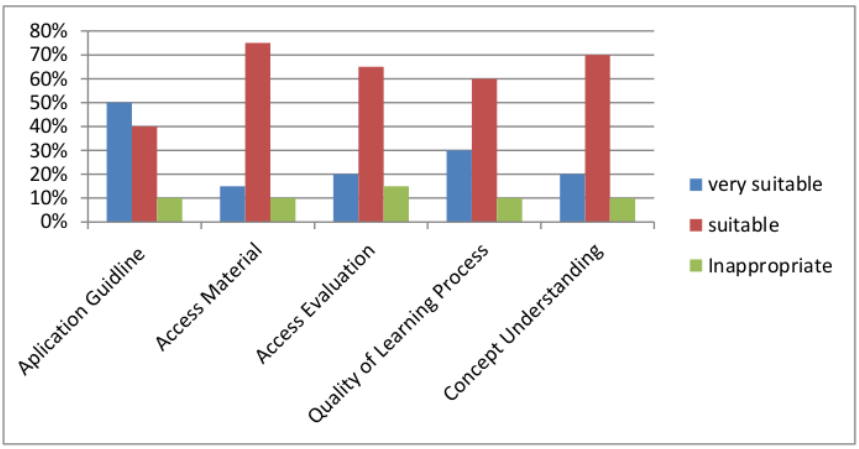

Figure 5. Limited experiment results

The users' reactions towards the formative e-assessment are 1) it is easy and clear to find the instruction on how to use the E-Assessment; 2) it is easy to implement E-Assessment by following the instruction provided; 3) it is to access the material given; 4) they understand the summary of the material presented; 5) it is easy to access the worksheet; 6) they get compatible assistance if the Students are wrong in doing the worksheet; 7) they clearly understand the assisted answers which appear on the worksheet; 8) they feel helped in doing the worksheet because of the clear answering guide which appears on the worksheet; 9) they get compatible feedback in the form of answer discussion if the students make mistakes in doing the worksheet three times; 10) it is easy to understand the answer discussion presented on the worksheet; 11) the compatible electronic worksheet can increase the users' achievement; 12) the compatible electronic worksheet can increase the users' curiosity and hardworking; 13) the compatible electronic worksheet can increase the users' critically thinking; 14) the compatible electronic worksheet can train the users' carefulness and honesty; 15) the attractive display of multiple Integral formative e-assessment.

3.3.4. Revision of the Product of Experimental Result. Based on the comments and advices from material validators, media validators, and experimental subjects; the researchers will revise the e-assessment product not thoroughly. It Is because of some reasons; one of which is observed by the heavier usage of moodle, and the formative e-assessment product is clear.

4. Conclusion

The researchers have conducted a research on development of ICT basis formative assessment. The first phase of the research was an introduction study consisted of distributing questionnaire, product developing, material and media expertise validation, small range experiment, and product revision. The product resulted is advisable and compatible to implement in Mathematical method of physics learning. Thus, it needs to be socialized since the beginning of the lecture that the learning of Mathematical method of physics will be implemented in online basis, both lecture and assessment. Limited experiment shows the increasing quality of mathematical methods for physics learning process.

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