Development of an online assessment based on the Shareable Content Object Reference Model (SCORM) to optimize the use of BeSmart UNY

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Abstract. This study aimed at developing an Online Assessment based on the Shareable Content Object Reference Model (SCORM) package. This study focused on: (1) obtaining an online assessment design based on SCORM package for the subject of Medical Instrumentation and Electronics based on needs analysis; (2) examining the functionality of the developed online assessment and (3) analyzing the usability of the developed online assessment. This software development process used the ADDIE development model. The testing stage of this study was conducted to verify and to validate the software. The software verification process was performed with functionality testing by media and material experts, and usability testing by users. The results indicated that: (1) it was obtained the design of an online assessment based on SCORM package for the subject of Medical Instrumentation and Electronics, including an online assessment in Besmart packed with SCORM Packages in the form of quiz integration (multiple-choice, short answer, true or false, drag and drop questions); (2) the functionality testing by material experts with a score of 3.88 and a media expert with a score of 4.16 suggested that the developed online assessment was feasible in the aspect of functionality; (3) usability testing by users achieved the score of 3.88 indicating that the developed online assessment was feasible in the aspect of usability.

1. Introduction

Instrumentation is a subject offered to students in the Bachelor Degree Program of Electronics Engineering Education. From 2013 until 2017, there have been several changes in the curriculum of the Department of Electronic Engineering Education which also drive the changes in the Course Learning Outcomes in the subject of Instrumentation. In the latest curriculum, the subject of Instrumentation has changed its name to Instrumentation and Medical Electronics. The expected Course Learning Outcomes of the course consist of: (1) being able to explain the concepts of Medical Instrumentation and Electronics required to analyze and to design electronic systems; and (2) being able to analyze issues and problems of the latest Medical Instrumentation and Electronic Technology as a solution for technological development. Changes in Course Learning Outcomes have impacted the availability of learning materials related to Medical Electronics. The addition of Medical Electronic

materials is a challenge to lecturers' strategy to teach the newly added materials to the students. Medical Instrumentation and Electronics have several sub materials with concepts that are difficult to understand by the lecture method without using media. However, materials delivery of Medical Electronics with actual equipment requires high costs.

The existing hardware learning media of the Instrumentation and Medical Electronics does not cover the entire materials, of which the Medical Electronic sub materials and learning multimedia do not yet exist. The media development is inseparable from the efforts of lecturers to increase the Course Learning Outcomes. However, the use of existing hardware learning media has not been optimized in learning. The existence of media limited in the laboratory causes students to not freely access and study independently repeatedly following the students' study time. Based on the experience of researchers as lecturers, students use the existing hardware media only in the laboratory practices. As a result, students experience difficulties when going to practice again. Students' initiative is taking photos and videos of the media during practices in the laboratory. The existing hardware media in the subject of Instrumentation and Electronics are used limited to the implementation of weekly practices. On the other hand, the assessment of students' learning outcomes is limited to theories and does not yet accommodate the existence of hardware media as one of the elements in the final examination**.** Therefore, optimization of existing hardware media must be conducted and the development of media both hardware and multimedia is required. This optimization is not limited to the development of media, but the implementation of the media in the learning process as well as one of the elements in the assessment.

The effectiveness of materials delivery of Instrumentation and Medical Electronics can be measured by analyzing the learning outcomes through the assessment process. The assessment conducted by the lecturers in the subject has not used the assessment facility in the university's e-learning platform namely Besmart optimally. Besmart is an online learning media facilitated by Universitas Negeri Yogyakarta (UNY). At Besmart, there is an online assessment with quite a large variety of assessment types. The learning process of the subject of Instrumentation from 2013 until now has not utilized all assessment activities at Besmart. Assessment facilities at Besmart are used only as a medium for uploading student assignments both home assignments and practice reports. The need for assessment elements to measure learning outcomes of Instrumentation and Medical Electronics which has not yet emerged is assessing the concept of understanding concepts and solving problems from the latest technology in instrumentation and medical electronics as a technology development solution. The assessment can be presented by visualizing the use of the latest Medical Instrumentation and Electronic Technology in the form of video hardware. It is intended to find out the overall targeted Course Learning Outcomes.

The remedial program was conducted only by retesting questions that have similarities with final examination questions. It has not been preceded by remedial learning to provide understanding to remedial students. Therefore, the results of the remedial program are under the expected Minimum Mastery Criteria. This causes a problem since, in vocational education, students are required to have a comprehensive mastery. If students do not comprehensively master the materials, it means that vocational education does not run effectively. Besides, the implementation of assessment and remedial programs has not been integrated into a system, where the lecturers are still doing the assessment manually. A manual assessment tends to have frequent errors in the calculation thus it requires a system to accelerate the assessment process with an accurate result . The question of the final examination is in the form of essays, so the subjectivity and negligence factors are considered to cause unreliable assessment results. Invalid assessment will not measure what it was designed to measure [2]

The targeted Course Learning Outcomes must be achieved by students, so for students who have not been able to reach it, they need to do the remedial program. Also, the remedial program is regulated in academic regulations. Lecturers have been conducting remedial programs without facilitating remedial learning for students. The students learn independently to prepare remedial assessment to reach the targeted Course Learning Outcomes. The remedial program will improve the students' learning outcomes if there is a learning effort by students. At present, there are not learning

media that accommodate the assessment, remedial material, and remedial program in one access. There is a SCORM Package at Besmart that accommodates lecturers to do assessments in the form of multimedia in the form of text, images, audio, and video. However, the use of the SCORM Package at Besmart has not been optimized in learning, especially in the subject of Instrumentation and Medical Electronics.

From the various previous descriptions, it can be seen that the subject of Electronic Instrumentation and Medical Electronics had several problems in its implementation including (1) exposure to Medical Electronics materials requires high costs; (2) the characteristics of Medical Instrumentation and Electronic materials have several concepts that are difficult to understand by lecturing methods without using media; (3) the existing of hardware media has not been optimized for use in learning and assessment; (4) there is still a lack of hardware media; (5) there is no multimedia learning; (6) the assessment facilities at Besmart have not been optimized by lecturers; (7) remedial implementation has not been preceded by pre-remedial learning; (8) final examination and remedial scoring do not yet use the system; and (9) there is no assessment, pre-remedial program and remedial learning in one access. The existence of SCORM package that can present media in the form of text, images, audio and video, one of them is in the form of online assessments The use of the SCORM package in the online assessment is considered to be a solution to the existing problems, especially the media hardware elements in the assessment, pre-remedial program and remedial learning in one access. Hardware media, in this case, is in the form of existing media and media that will be developed. Therefore, the objectives of this study were: (1) to obtain an SCORM package based online assessment design for the subject of Instrumentation and Medical Electronics based on needs analysis, (2) to examine the functionality of the SCORM package-based online assessment in the subject of Instrumentation and Medical Electronics, (3) to analyze the usability of the SCORM package-based online assessment in the subject of Instrumentation and Medical Electronics.

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2. Method

The development procedure in this study referred to the R&D research design, the ADDIE model developed by Dick and Carry [1] to design learning systems. ADDIE stands for Analysis, Design, Development, Implementation, and Evaluation. Figure 1 shows the 5 stages of ADDIE.

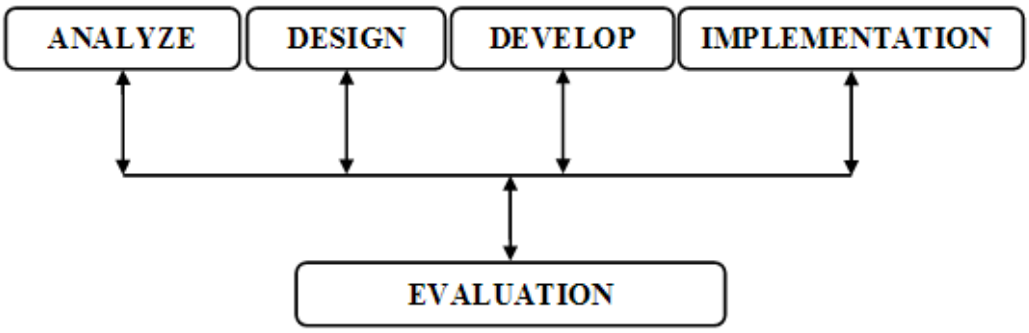

Figure 1. ADDIE system design

The stages of the ADDIE model according to Chaeruman [2] are as follows:

(1) Analyze stage
In this stage, there was a need assessment (needs analysis), problem identification (needs), and task analysis. The output from this stage was in the form of product characteristics or specifications following the results of the analysis. The analysis adopted the stages used by Lee and Owens [3], namely the front end analysis in the form of audience analysis, technology analysis, task analysis, critical incident analysis, and objective analysis.

(2) Design

The design phase included the development of objectives, test items, and strategies which were then made into product design with a blueprint design. This stage was also known as designing.

(3) Development
In the development stage, it was tried to realize the blueprint design. At this stage, everything needed to support the process of developing an online assessment system must be prepared.

(4) Implementation
The implementation phase implemented an online assessment system product by utilizing Besmart.

(5) Evaluation
The evaluation process focused on improving the online assessment system based on user response. A product test instrument was made based on a theoretical study of the usability of an online assessment system assessed by the user.

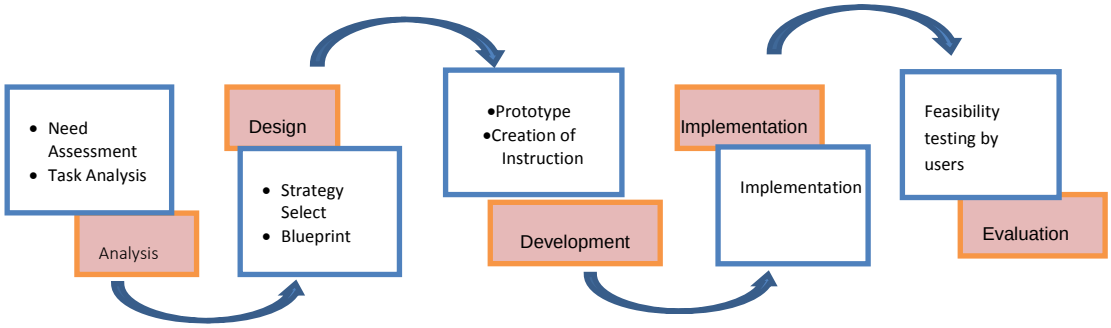

Figure 2. Stages of the ADDIE Model

2.1. Research subjects

The subjects in this study included: (1) 35 students and 3 lecturers of the Study Program of Electronic Engineering Education in the academic year of 2015 at the needs analysis stage (front end analysis); (2) 4 students (representatives of the Study Program of Electronic Engineering Education in the academic year of 2015 and 2016) and 6 lecturers of the Department of Electronics and Informatics Engineering (as material experts, assessment experts and media experts) at the needs and design analysis stage (focus group discussion); (3) 2 people for performance testing; (4) four expert judgments (material experts, and media experts) for online assessment validation; and (5) 38 students of the Study Program of Electronic Engineering Education in the academic year of 2016 who took the subject of Medical Instrumentation and Electronics.

3. Results

3.1. Requirements analysis

Requirement analysis was carried out before conducting product development including aspects of technical analysis, critical incident analysis and objective analysis. The following needs analysis results were obtained:

(a) Technology Analysis Aspects
(1) Besmart is used as one of the tools in learning
(2) Besmart features that are used: uploading material files, forums, chat, uploading student assignments, quizzes; One of the SCORM packages features, scoring features that have not been used Yat
(3) Assessment is done using besmart: uploading assignments and quizzes
(4) There are reports on the results of assessments that can be accessed by students at any Time

(5) Media required are media which accelerate critical thinking skills and can help the development of students' creativity (the results of the reconstruction of the course) and adjust the learning model (Project Based Learning), through the use of pre-assembled media, where users simply plug components into available places (already connected supply voltage) and completely includes the voltage supply block, breadboard for installing sensors, signal conditioning blocks and output blocks (representing the amount of light, sound, motion); relevant and available trainers are practical media but there is only one device and the operation tends to be less safe (experience in learning); The use of practical media is limited to users in the laboratory, students have limited access outside the laboratory.
(6) Practice media are used in the face to face assessment, there is no documentation of practice media
(7) The use of tools and materials is limited to practical learning

(b) Aspects of Critical-incident Analysis and Objective Analysis
(1) Documents contain the achievement of Course Learning Outcomes
(2) Learning uses a student-based approach
(3) Learning uses the Project-Based Learning model
(4) There is a mismatch between the model, materials, and assessment; where the materials and the use of media is not optimal and the existing media cannot support the learning of the PjBL model, there is no synchronization of learning components
(5) All learning materials in the syllabus have not been successfully conveyed (the practical constraints of using a project board that experiences many problems (separate supply); the materials consist of instrumentation concepts (process quantities, sensors, signal conditioners, outputs); body systems, anatomy, physiology, medical information, medical electronic equipment; issues, problems, and development of Medical Instrumentation and Electronics
(6) Assessment is adjusted to the Semester Program Plan
(7) There is an assessment for all learning materials
(8) There is more than one assessment, the types of assessment methods are limited to essay questions
(9) There are grading grids
(10) There is an assessment rubric
(11) Lecturers have problems in making corrections to students' assessment results
(12) The assessment is entered manually for the final assessment
(13) There are remedial program but the implementation is not carried out based on remedial materials
(14) There is no remedial learning for students who take the remedial assessment

(c) Conclusions of Need Analysis (Specifications)
(1) The online assessment is developed with the powerpoint application and packaged with iSPRING8 and displayed on the SCORM feature at Besmart UNY
(2) The online assessment consists of assessments in the form of multiple-choice tests, true-false tests, drag and drop and short answers by displaying the elements of hardware media in the assessment. Chronology of use, i.e. students are declared to have passed if they meet the targeted Course Learning Outcomes, and there are pre-remedial learning activities in the form of multimedia before the implementation of the remedial assessment for students who have not achieved the targeted Course Learning Outcomes.
(3) Pre-remedial learning activities contain material reviews along with videos on the use of hardware media.

(4) The online assessment is accessed by students by logging in as participants of the Medical Instrumentation and Electronics course at Besmart using all browsers
(5) The required practical media are media that accelerates critical thinking skills and creativity (the results of the reconstruction of the course) and adjust the learning model used (Project Based Learning), through the use of pre-assembled media, where users simply plug the components into the appropriate place available (already connected supply voltage) and completely load voltage supply block, breadboard for installing sensors, signal conditioning blocks and output blocks (representing the amount of light, sound, motion)

3.2. Product design

Before doing product development, firstly, it was determined the design of the product, which included:

(1) Quiz
The quiz was designed by filling in the students' identity (name) first.
(2) Scoring
(3) The scoring design includes grading and remedial determination. The remedial students can access everything.
(4) Materials Access
Before the remedial program, the students can access all of the materials. Remedial students only can access certain materials that need to be improved in the remedial program.
(5) Remedial Assessment
Remedial assessment is determined by minimum scores that should be achieved by the students. If the score obtained is less than the standard, students are required to take a remedial program and assessment.

3.3. product development

After conducting the requirements analysis and product design, the next stage of development includes (1) Compilation of grids, namely formulating questions and assessments grids, (2) Making navigation, i.e. making various menus, buttons to access materials, (3) Coding, which uses macros VBA programming on power points, and (4) Performance, which tests each menu function (test case).

4. Discussion

4.1. Results of the product assessment

4.1.1. Material expert assessment

The material assessment was conducted to validate the materials displayed by the application. It was carried out by giving questionnaires to the experts. The selected material experts are lecturers of Medical Instrumentation and Electronic. The assessment was carried out using instruments that have been prepared. The material expert testing obtained a score of 3.88 included in the feasible category and the minimum criteria were sufficient.

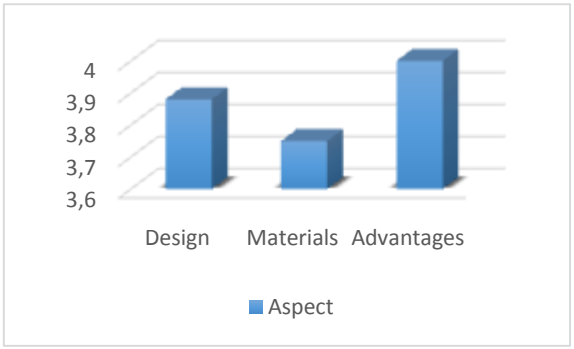

Figure 3. Results of materials expert assessment

4.1.2. Media Expert Assessment

Validation testing by educational media experts was carried out to validate the software developed based on the opinion of educational media experts. Educational media experts conducted software testing to determine software problems in the developer's perspective environment. The test results showed a score of 4.16 included in the feasible category and the minimum criteria were sufficient.

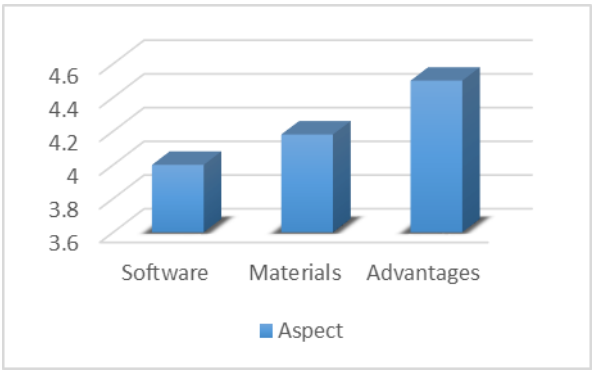

Figure 4. Results of media expert assessment

4.1.3. Usability Testing by Users

Usability testing was conducted by students as users. This was conducted to determine the usability of the developed software based on users' opinions. The score was 3.88 included in the feasible category and the minimum criteria were sufficient.

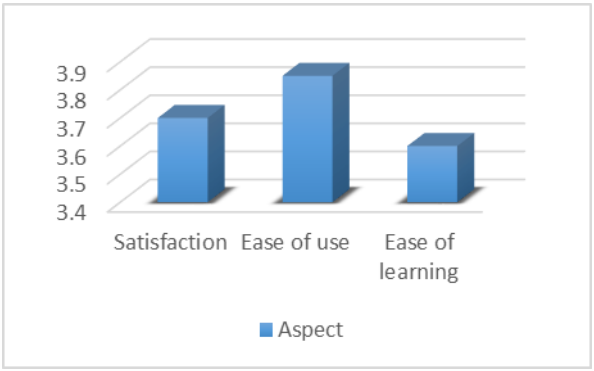

Figure 5. Results of usability testing

4.2. Final product

Online Assessment software that has been developed had the following kriteria (1) The online assessment was developed with the powerpoint application and packaged with iSPRING8 and displayed on the SCORM feature at Besmart UNY, (2) The online assessment consisted of assessments in the form of multiple multiple-choice, short answer, true or false, drag and drop questions by displaying the elements of hardware media in the assessment. Chronology of use, i.e. students were declared to have passed if they met the targeted Course Learning Outcomes, and there were pre-remedial learning activities in the form of multimedia before the implementation of the remedial assessment for students who had not achieved the targeted Course Learning Outcomes, (3) Pre-remedial learning activities contained material reviews along with videos on the use of hardware media, (4) The online assessment was accessed by students by logging in as participants of the Medical Instrumentation and Electronics course at Besmart using all browsers, and (5) The media required are media that accelerates critical thinking skills and creativity (the results of the reconstruction of the course) and adjust the learning model used (Project Based Learning), through the use of pre-assembled media, where users simply plug the components into the appropriate place available (already connected supply voltage) and completely load voltage supply block, breadboard for installing sensors, signal conditioning blocks and output blocks (representing the amount of light, sound, motion).

5. Conclusion

Based on the results obtained from the study, the conclusions consisted of (1) a SCORM package based online assessment design for the subject of Medical Instrumentation and Electronics was developed, including an online assessment at Besmart with SCORM Packages in the form of quiz integration (multiple-choice, short answer, true or false, drag and drop questions), a remedial program based on password and teaching materials. Teaching materials and assessments contained the use of practical media to accelerate critical thinking and provide opportunities for students to develop creativity, (2) the functionality testing of the developed SCORM package-based online assessment was conducted by material experts with a score of 3.88 and media experts with a score of 4.16 respectively. Based on the scores, the developed online assessment was considered feasible in terms of functionality and (3) the usability testing of the developed SCORM package-based online assessment was conducted on users with a score of 3.88. It indicated that the developed online assessment was declared as feasible in terms of usability.

6. References

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