Design of multiple representations e-learning resources based on a contextual approach for the basic physics course

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Abstract. This research aims to design e-learning resources with multiple representations based on a contextual approach for the Basic Physics Course. The research uses the research and development methods accordance Dick & Carey strategy. The development carried out in the digital laboratory of Physics Education Department, Mathematics and Science Faculty, Universitas Negeri Jakarta. The result of the process of product development with Dick & Carey strategy, have produced e-learning design of the Basic Physics Course is presented in multiple representations in contextual learning syntax. The appropriate of representation used in the design of learning basic physics include: concept map, video, figures, data tables of experiment results, charts of data tables, the verbal explanations, mathematical equations, problem and solutions example, and exercise. Multiple representations are presented in the form of contextual learning by stages: relating, experiencing, applying, transferring, and cooperating.

1. Introduction
Electronic-based learning technologies include: internet usage and device in producing material for learning, teaching students, and manage the learning process so well organized. E-learning, according to the OECD (2005) is defined as the use of information and communication technologies in the educational process to support and enhance learning in institutions of higher learning, including the use of information and communication technology (ICT) as a complement to the traditional classroom, online or a mix of both studies [1]. E-learning can be viewed as computer-assisted learning, and as a collaborative student learning-centered pedagogy. At the beginning of its development, e-learning focused on using computer in learning activities, part or whole of learning content delivered digitally. Current pedagogical dimension also highlighted in e-learning resources development. E-learning consists of all forms of learning and teaching are supported electronically. Information and communication systems, using the network or whether, has a function as dedicated media to implement the learning process [2]. E-learning in higher education, require increased competency of lecturers as needed in addition to the capabilities in the field of science, which is supported by an adequate ICT infrastructure, knowledge about innovative tools in learning, competence in the university learning, as well as media information and its literature [3].

Physics is a part of science that studies the natural phenomena and the interconnection between its phenomena. In learning physics, students are required to manage multiple representations. A physics curriculum focused on modeling based on the framework of multiple representations. Multiple representations are a model for presenting and repeated the same concept in several different formats [4]. Multiple representations also mean showing the same concept with different formats, including
verbal, text and animated images, diagrams, tables and graphs, algebra notation, as well as tables and mathematical equation [5]. The method of multiple representations should be the main strategy in learning physics process. It is based on two reasons. First, the study of physics should reflect on the learning model that directs a searching knowledge process and the introduction of the knowledge product. The second reason, a varied approach should be in learning physics, especially to reduce the misunderstanding the physics concept. The researchers tried to use the method of multiple representations to describe physical phenomena. In this research, has been developed where the empirical mathematics modeling capabilities students tested and referred to the ability to interpret physical phenomena, and the result is a multiple approach to the representation of science in the process of learning physics able to make students better in resolving problems in learning physics [6]. The use of multiple representations proved a positive influence in increasing the effectiveness of learning physics. Multiple representations can build a deeper understanding of students by providing complete information from a variety of perspectives are presented. Multiple representations, make students creative thinking by linking these forms of representation with the application of a natural phenomenon that occurs [7]. Representation presented in learning physics must be contextual.

Contextual learning puts mastery context studied by learners. Learners understand the meaning of the material he had learned. A contextual approach is rooted in constructivism approaches. Students are expected to build knowledge through interaction and its interaction with the environment. Students build knowledge through experience and the context which not formed by a teacher. Five of these strategies, called contextual teaching strategies: Relating-learning in the context of one's life experiences or preexisting knowledge; Experiencing – learning by doing, or through exploration, discovery, and invention; Applying-learning by putting the concepts to use; Cooperating-learning in the context of sharing, responding, and communicating with other learners; Transferring-using knowledge in a new context or novel situation-one that has not been covered in class [8].

And the purpose of this research is to develop e-learning resources for basic physics courses are presented in multiple representations and contextual.

2. Methods
This study refers to the Dick & Carey research and development model, with several research steps from identification to evaluation [9]. The activities in each step in this research were conducted at the Universitas Negeri Jakarta. The steps are described as follows.

2.1. Identify Instructional Goals
In this step, identified the competence of graduates of physical education courses Faculty of mathematics and natural sciences of the Universitas Negeri Jakarta to formulate a general purpose basic physics lecture for student education courses Physics.

2.2. Conducting Instructional Analysis
The next step is to analyze the general objective learning to formulate competencies must be have after the basic physics lecture. This analysis is required to ensure that competency courses build the competence of graduates as defined by the Department. Competencies define the skills and knowledge students should have by the end of the lecture.

2.3. Analyze Learners and Contexts
The next stage is to identify entry behaviors and learner characteristics to determine the competencies that should be already and competencies will be built by the student. The ability of the early student is required to determine the design of the contextual learning. Accurate identification of students about the characteristics of the basic physics lecture participants will assist the design of learning programs in determining and establishing e-learning strategy.
2.4. Writing Performance Objectives
Based on previous stages, at this stage we wrote the learning objectives to be accomplished students basic physics lecture participants for each of the competencies already formulated.

2.5. Develop Assessments Instruments
This stage to develop a form of assessment and the instruments that will be used to measure the competence of the basic physics course. The instrument was drawn up based on the learning objectives in the previous stage.

2.6. Develop Instructional Strategy
This step is developing learning strategies developed in the e-learning system of basic physics. Learning strategies are contextually presented by displaying multiple representations.

2.7. Develop and Select Instructional Materials
Based on the chosen strategies, conducted the selection and development of the learning material. Select the representation of video, images, animation, data, graphs, equations of mathematical physics learning materials relevant to the basic contextual, then design the represent learning materials into the e-learning system.

2.8. Design and Conduct Formative Evaluation of Instruction
Activities in this stage include designing a formative evaluation to improve e-learning resources for use in basic physics course in the Department of Physics Education of the Universitas Negeri Jakarta. This evaluation includes: instructional design shown in the e-learning system; the material is presented to establish the competence of the students on the basic physics courses; the accuracy and appropriateness of the displayed representation; the suitability of the exposure to the material with the intention of learning; the suitability of the material exposure with an instrument rating. A formative evaluation was also done to the user: students and lecturers, associated with the effectiveness of users of e-learning support the learning process.

2.9. Revise instructional
The main one of these stages is doing revisions for finalization the e-learning resources of basic physics courses based on the results of the formative evaluation. A revision of all aspects that are found either from the weakness of the e-learning strategy and its representation.

3. Results and Discussion
The learning activities of basic physics course based on a contextual approach in multiple-representation is improving student understanding of the concept study. The following described the presentation of multiple representations corresponding to the syntax of a contextual approach.

3.1. Relating Phase
Any material begins by displaying the concept map. This concept map linking material physics that studied the material physics that students already owned. At the beginning of the material to be shown a video that describes the phenomenon of media associated with the material to be studied. The representations shown in this phase are: (1) concept map, and (2) introduction video, as indicated in Figure 1 and Figure 2.

3.2. Experiencing Phase
Multiple representations presented in the exposure e-learning basic physics lecture will provide experience for students in exploring concepts, inventions concepts, and an explanation of the concept. The representations shown in this phase are: (1) Figure of the phenomenon, (2) Exploring concepts
video, (3) Experiment data tables, (4) Graphic of data tables, (5) Verbal explanation, and (6) Mathematical equations, as shown in Figure 3 until Figure 8.

**Figure 1.** Concept maps.

**Figure 2.** Introduction video.

**Figure 3.** Figure of phenomenon.

**Figure 4.** Exploring concepts video.

**Figure 5.** Experiment data tables.

**Figure 6.** Graphic of data tables.

**Figure 7.** Verbal explanation.

**Figure 8.** Mathematical equations.
3.3. Applying Phase
E-learning resources is also equipped with video applications of the concepts learned, examples of cases so students can do calculations in accordance with the principles and legal study. The representations shown in this phase are: (1) exercises and (2) problem-solution example, as shown in Figure 9, 10.

3.4. Cooperating Phase
The E-learning resource is equipped with communication media, in the form of chat facilities and discussion forums. In understanding the concepts of physics that is in the device's e-learning, students can interact with lecturers and other students in the context of the share, respond, and communicate.

3.5. Transferring Phase
Each of the concepts presented are equipped with exercise to assist students in transferring his understanding. The results of the work of the student in resolving the problem give an overview of students' level of understanding towards the concepts studied.

3.6. The Validation Result
The validation results by peers using learning process and media instruments. These assessments are corrections and suggestions on learning tools as shown in Table 1.

| Feedback from Peers | Revisions Made |
|---------------------|----------------|
| Learning Process (Peer 1) | The stage of experiencing phase should connect between the visualized graph and the data table. | E-learning resource displays a graphical representation that is a linked representation with the data table. |
| Learning Process (Peer 2) | At the applying phase stage, the exercise should be the same kind as the example of the problem discussed. | All the problems in the exercise are in accordance with the example. |
| Learning Media (Peer 1) | The instructional videos displayed also feature short text as described to clarify video intent. | Each learning video has been completed with text to clarify the purpose of the video. |
| Learning Media (Peer 2) | Exercise integrated online. | Student exercise data are recorded in the database online. |
After revision, the revised e-learning resource is then re-quantized and generated so that it can be used for preliminary testing. This assessment uses a questionnaire which is summarized as shown in Table 2.

| Table 2. The Results of the Questionnaire from Peers |
|---------------------------------------------------|
| Peer 1 | Peer 2 | Average |
| Learning Process | 91% | 85% | 88% |
| Learning Media | 83% | 88% | 85.5% |
| Average | | | 86.75% |

3.7. The Preliminary Test Result
The result of preliminary test of e-learning resource towards the student gives the model of e-learning according to physics learning characteristic. The e-learning model for the Basic Physics course is presented in multiple representations of science by displaying: concept map, introduction video, figure of the phenomenon, exploring concepts video, experiment data tables, graphic of data tables, analysis of graphics, mathematical equations, verbal explanation, exercises, and problem-solution example. E-learning is also equipped with evaluation tools to measure learning achieved by online.

4. Conclusion
The use of a multi representation in learning basic physics support contextual learning. Multiple representations displayed contextual in the e-learning basic physics course can increase student understanding of the concept study. Any material showing representations such as: concept map, figure, table, video experiment results, the graphs of the data table, the study of the verbal, mathematical equations, examples of matter, and matter of practice [5]. Multiple representations is presented in the form of contextual learning by stages: relating; experiencing; applying; cooperating; and transferring phases [7]. Basic physics with multi exposure representation of science in the learning process of physics are expected to make students better in resolving problems in learning physics [6].

Further research is to determine quantitatively the influence of the use of resources developed for increased understanding of the students.

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