Original Research Article

Development of Microlearning Content for Software Engineering Courses by Using ADDIE Model

ABSTRACT

This research aims to: (1) Develop an e-learning design model based on micro-learning content, (2) Analyze the validity of the developed micro-learning content-based e-learning design model, (3) Analyze the practicality of the microlearning content-based e-learning design model for Engineering courses Software, (4) Analyzing the effectiveness of e-learning design models based on microlearning content for Software Engineering courses. This type of research is Research and development (R&D) with the Analysis, Design, Development, Implementation, Evaluation (ADDIE) development model. Data collection techniques used questionnaires and tests. The data analysis technique used qualitative descriptive statistical analysis. The resulting product was validated by model experts, material experts and media experts, while the trials carried out were small group trials and expanded trials. The results of the research are: (1) producing an e-Learning Design Development Model based on Microlearning Content and model supporting products with research and development stages consisting of 5 stages, namely Analysis, Design, Development, Implementation. and Evaluation which are divided into 3 major stages, namely a) Microlearning Modeling; b) Microlearning Development; c) Microlearning Implementation, (2) The results of assessing the validity of model and model product by experts respectively produced an average score of 87.1% and 84.5%, both of which were categorized as very feasible or valid, in order that the model product is suitable for testing in field, (3) The results of the practicality test of the model from student and lecturer respondents respectively obtained an average score of 87.5% and 87.2%, both of which were categorized as very good or very practical, (4) The model was declared effective based on the results of the score calculation N-Gain is based on student pre-test and post-test scores. The N-Gain score obtained was more than 76% or categorized as effective. This showed an increase in students' abilities before and after using the model for the Software Engineering course.

Keywords*:e-Learning Design Models, Microlearning Content, Software Engineering*

INTRODUCTION

The use of information and communication technology in education for teaching is very necessary in overcoming various obstacles in the teaching and learning process such as distance, time, infrastructure and very fast information exchange. The drastically increasing use of e-learning in the education sector has led to the need to provide adequate electronic content and pay attention to various aspects, especially the conditions of modern learners(Bersin,2015; Docebo, 2017).

Today's continuous demands for complexity and competition require students to always increase their capacity and capabilities. In order that students can increase their knowledge and skills capacity, efficiency in learning becomes one of the most important things. Efficiency can be obtained by applying e-learning and multimedia learning design principles properly and correctly (Clark, 2017;Leacock, 2007). One strategy that can be implemented is to present learning content in small sizes or microlearning (Hug, 2005;Greany,2018).

In microlearning paradigm, complex learning content is presented in small chunks or bit sizes in order that it is easy to digest and can be remembered by students for a long time(Hug,2005;Major,2018;Paul,2016;Shatto,2018).Apart from that, microlearning content is designed to adapt to the human brain's ability to absorb knowledge, and depth of material and avoid the emergence of boredom among students (Aitchanov, et al.,2013; Jomah, 2017;Liu,2016).

Some of the advantages and goals of using microlearning are that the lesson material is easy to understand, easy to convey, and can be retained or remembered for a long time (Giurgiu, 2017; Sirwan Mohammed, et al., 2018; Wang, 2017; Zhamanov, 2013), makes students more focused during learning in the short term and does not lose understanding due to the emergence of boredom due to long periods of time (Renard, 2017). Besides that, the use of microlearning is in line with the theory that the human brain's ability is generally easier to understand and remember material presented in a short time. According to Cortez (2018), to help avoid cognitive overload and boredom, complex material is broken down into smaller pieces or units. Another benefit of microlearning from the teacher's side is the ease of preparing and reproducing material

because it requires relatively less time than normal learning (Renard, 2017). Apart from that, in terms of cost efficiency, the cost of training with microlearning is relatively smaller than normal learning (Malamed, 2015). To realize the advantages of the nature of microlearning in learning, it needs to be realized in the form of a microlearning content design model.
The hope of this article is to promote amicrolearning content design model for teachers as an alternative that can be chosen in preparing learning content that will be used in e-learning. Because it is still a new model, it is necessary to carry out an R&D research study.

METHODS

R&D-based microlearning content development is realized using the ADDIE approach which consists of 5 stages, namely Analysis, Design, Development, Implementation and Evaluation as in Figure 1 (Branch, 2009)

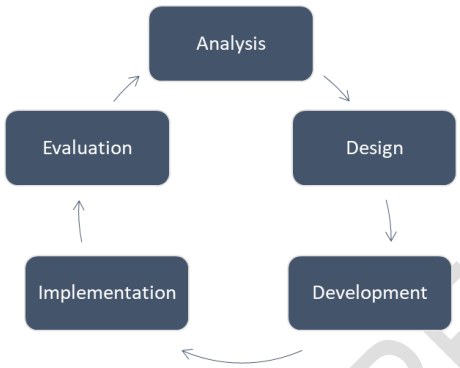

Figure 1.Schematic of ADDIE development procedures for microlearning content design models

The R & D research stage consists of several stages. This stage of R&D will use the ADDIE model, which consists of 5 stages, namely 1) Analysis, the analysis stage is a process of defining what will be learned by learning participants 2) Design, this stage is realizing the results of the analysis in the form of a design (blueprint) 3)Development, this stage is the process of turning the blueprint into reality, namely the product; 4) Implementation, is a concrete step to implement the learning system that is being created and 5) Evaluation. Evaluation is a process to see whether the learning system that is being built is successful, in accordance with initial expectations or not.
The five stages of ADDIE are divided into 3 major stages, namely 1) Microlearning content modeling, consisting of the Analysis and design stage, 2) Microlearning content development, containing the Development stage and 3) Application of microlearning content, containing the Implementation & Evaluation stage.

RESULT AND DISCUSSION

The performed research and development activities have yielded several noteworthy outcomes. A novel e-Learning Design Development Model has been devised, which incorporates Microlearning Content and model-supporting products specifically tailored for Software Engineering lectures. The purpose of this model is to enhance the learning experience for students, with a specific focus on the domain of software engineering, by increasing effectiveness and efficiency.
Furthermore, the assessment of the model's validity and the goods derived from it was conducted by administering a questionnaire to specialists within the relevant subject. The efficacy of the model has additionally been evaluated through the administration of a questionnaire, which was completed by both students and lecturers. The assessments have yielded significant feedback regarding the efficacy of the model, contributing to its refinement and enhancement.
The efficacy of the strategy has been evaluated by means of student learning assessments, namely pretest and posttest scores. The findings from these assessments indicate that the implementation of the e-Learning Design Development Model, which incorporates Microlearning Content and supporting products, has proven to be efficacious in enhancing student learning outcomes in the context of Software Engineering lectures. The discovery presented holds considerable implications for enhancing the educational standards within the domain of software engineering.
In general, the research and development endeavours have yielded a significant contribution to the domain of education, with a special emphasis on the discipline of software engineering. The potential of the e-Learning Design Development Model, which incorporates Microlearning Content and model-supporting products, lies in its ability to enhance the educational quality and optimise the learning experience for

students in the field of Software Engineering lectures. The outcomes of the tests have yielded significant feedback regarding the efficacy of the model, hence facilitating its refinement and enhancement.
The research and development carried out consisted of 5 stages, namely Analysis, Design, Development, Implementation and Evaluation which were divided into 3 major stages, namely a) Microlearning Modeling; b) Microlearning Development, c) Implementation of Microlearning.
The stages of microlearning content design are shown in Table 1.

Table 1. The stages of microlearning content design

Content design stage	Example Activity	Example Output
Microlearning Content Modeling Stage		
Analysis: **is the stage of defining what/content to be learned**	Library & Field Studies Content Needs Analysis System requirements analysis	Results of identification of microlearning content standards Student Profiles Content/Task/Tools/System identification list
Design: **is the stage of realizing the specifications of what will be studied**	Designing a Content Map Designing Media Content Outlines Write storyboards Designing a content delivery strategy Designing a formative test	Content Map Media Content Outlines Storyboards Content delivery strategy Test items
Microlearning Content Development Stage		
Development: **This is the stage of creating and producing content/teaching materials**	Preparation of content technical guidelines (specifications) Developing microlearning content Production and validation of microlearning content (prototype)	Content technical guidelines(specifications) Prototype Feedback from validators
Microlearning Content Implementation Stage		
Implementation: **The process of installing microlearning content in real-world contexts.**	Install content on the Learning Management System (LMS) Conduct trials on students/lecturers	Feedback from students/lecturers
Evaluation: **Process to measure the success rate of the project**	Doing tests / Giving questionnaires Make revisions	Test result report Recommendation Prototype improvements

The model validity includes aspects of rationalization, basic theory development, syntax, social system, reaction principle, support system, instructional impact, and accompanying impact. The results of assessing the model validity and model product by experts respectively produced an average score of 87.1% and 84.5%, both of which were categorized as very feasible or valid so that the model product was suitable for testing in the field.
Furthermore, the practicality testing aspects include aspects of clarity of learning instructions, readability, image/video display quality, flexibility,useability of Microlearning, and independence and motivation. Based on the results of the model practicality testing questionnaire, student and lecturer respondents respectively obtained an average score of 87.5% and 87.2%, both of which were categorized as very good or very practical.
Testing the effectiveness of the model is measured through student learning outcomes in the form of pre-test and post-test scores. Based on the results of calculating the students' pre-test and post-test N-Gain scores, the model was declared effective. The N-Gain score obtained was more than 76% or categorized as effective. This shows an increase in students' abilities before and after using the model for the Software Engineering course.
Based on the N-Gain value, it can be seen whether the application of the model is effective or not.
The formula for N-Gain is

$$N - Gain = \frac{Skor\ Posttest - Skor\ PreTest}{\text{Skor Ideal} - \text{Skor PreTest}} \qquad (3.3)$$

The efficacy of microlearning-based e-learning content items generated can be assessed in this study by examining the pre-test and post-test scores of students, which serve as a benchmark. This study employed a

pretest and post-test design to assess the impact of three learning modules on a sample of 20 students. The overview of pre-test and post-test test results is presented in Table 2.

Table 2. Summary of Pre-Test and Post-Test Results

	Module 1		**Module 2**		**Module 3**	
Value	*Pre-Test1*	*Post-Test1*	*Pre-Test2*	*Post-Test2*	*Pre-Test3*	*Post-Test3*
Average	58.3	90.5	55.8	90	52.8	89.0
Standard deviation	9.3	7.2	12.5	5.7	16.1	8.3

Source: Processed Data, 2023

The evaluation of the model's efficacy was conducted by determining the N-Gain score, which was derived from the pretest and posttest results of the three modules administered to the student participants. The subsequent passage provides an overview of the mean N-Gain scores for each module, specifically Module 1, Module 2, and Module 3, as depicted in Table 3.

Table 3. Model Effectiveness Test Results (Ability Improvement Test) with N-Gain score.

No	**Module 1**			**Module 2**			**Module 3**		
	Pre Test1	**Post Test1**	**N-Gain Score (%)**	**Pre Test2**	**Post Test2**	**N-Gain Score (%)**	**Pre Test3**	**Post Test3**	**N-Gain Score (%)**
1	65	90	71.43	75	95	80.00	65	95	85.71
2	55	95	88.89	55	90	77.78	75	95	80.00
3	50	80	60.00	50	90	80.00	80	90	50.00
4	55	80	55.56	55	85	66.67	60	85	62.50
5	50	85	70.00	50	85	70.00	70	100	100.00
6	60	90	75.00	60	90	75.00	60	90	75.00
7	70	100	100.00	65	100	100.00	35	90	84.62
8	65	95	85.71	65	95	85.71	30	75	64.29
9	70	90	66.67	75	90	60.00	50	80	60.00
10	60	100	100.00	40	90	83.33	45	75	54.55
11	65	90	71.43	80	100	100.00	80	100	100.00
12	60	90	75.00	60	80	50.00	35	90	84.62
13	40	80	66.67	35	90	84.62	30	70	57.14
14	60	100	100.00	60	90	75.00	55	90	77.78
15	70	90	66.67	55	90	77.78	45	90	81.82
16	40	95	91.67	45	75	54.55	45	95	90.91
17	60	95	86.61	40	95	91.67	40	90	83.33
18	45	75	54.55	55	90	77.78	70	100	100.00
19	55	100	100.00	35	90	84.62	35	95	92.31
20	70	90	66.67	60	90	75.00	50	85	70.00
Average			**77.63**			**77.47**			**77.73**

Source: Processed Data, 2023

According to the findings from the computation of the N-Gain score presented in Table 3, it is evident that the average N-Gain values for the three Modules under investigation, namely Module-1, Module-2, and Module-3, are 77.63%, 77.47%, and 77.73% correspondingly.

Table4.N-Gain Score criteria for model product effectiveness

Score Range N-Gain (%)	Meaning
G>=76	Effective
56 - 75	Moderately effective
40 - 55	Less Effective
G<=39	Not effective

Source: Hake, R.R (1999)

Based on the calculated average N-Gain values of the three modules above the threshold of 76%, it can be inferred that there is a discernible improvement in student skills when comparing their performance before and after the implementation of the microlearning content-based instructional approach. Consequently, the efficacy of this instructional model can be classified as noteworthy.

CONCLUSION

Based on the findings derived from the performed research and development endeavours, it can be inferred that a Microlearning Content-based e-Learning Design Development Model has been effectively generated, together with an accompanying model supporting products specifically designed for Software Engineering courses. The purpose of this model is to enhance the efficacy of learning through the utilisation of e-learning technology and customisedmicrolearning content that caters to individual learning requirements.

The experts have evaluated the validity of the model and the goods that support the model through the administration of questionnaires. Furthermore, the feasibility of the concept has been assessed by the administration of questionnaires to both students and instructors. The assessment results indicate that the created model and its associated support products demonstrate strong validity and practicality.

The efficacy of the model has been evaluated by measuring the educational achievements of students prior to and after their utilisation of the model. The findings of this evaluation demonstrate that the utilisation of the model has the potential to enhance the efficacy of student learning.

Therefore, it can be inferred that the Microlearning Content-based e-Learning Design Development Model, together with its associated products, has the potential to enhance the efficacy of learning in Software Engineering courses. This model can serve as a valuable point of reference for the development of e-learning in various domains, considering diverse learning requirements.

Consent

As per international standards or university standards, respondents' written consent has been collected and preserved by the author(s).

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