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The Positive Impact Of Virtual Class-Based On Calculus II Teaching Materials In Improving The Conceptual Understanding Of Informatics Engineering Students

Tesi Anggraini[1*], Wardani Rahayu[2], Makmuri[3]
[1,2,3] Universitas Negeri Jakarta, Jakarta, Indonesia
Email: tessyanggraini07@gmail.com, wardanirahayu@unj.ac.id, makmuri@unj.ac.id

Abstract

This research aims to analyze the validity of Calculus II teaching materials based on virtual classes; the effectiveness of teaching materials that have been designed towards improving students' understanding of mathematical concepts. The method used in this research is ADDIE model (Analysis, Design, Development, Implementation and Evaluation). The research subjects were students of Informatics Engineering UNINDRA 4th semester who took Calculus II courses consisting 2 (two) classes, namely the experimental class consisting of 14 students and 15 students of the control class. Instruments and data collection techniques used in the form of observation, tests, and questionnaires. Data analysis used independent sample test and normalized gain score. The result showed that Calculus II teaching materials were based on virtual class was valid and effective to improve students' understanding of concepts so it can be concluded that the teaching materials for Calculus II based on virtual classes are valid and suitable for use in learning and are effective and practical to improve student's conceptual understanding.

Keywords: *Teaching Materials, Virtual class and Concepts' Understanding.*

1. Introduction

The use of technology and information in education, one of which is the learning process, can be done using ICT. There are three roles of ICT in a learning process: As education media, it is used to elucidate the material transfer in the class. As a piece of information, and the last one is ICT as a learning system that supports the continuity and smoothness of the learning process (Nisa et al., 2015; Sholihah, 2012). The role of ICT as the source of information is the technology application as computer-based learning materials. One of the benefits of ICT development is the use of e-learning.

The application of e-learning in the form of virtual class in Mathematics learning is a breakthrough that is expected to be able to increase students' motivation to study because in virtual class learning there is a direct interaction between the students with the materials, the assignments, and the evaluation. This direct interaction is such an active learning process from the students that the lecturer as a facilitator. Professional lecturers prioritize the quality of their teaching process over their material orientation. As facilitators, the lecturers do not only give information, but also, they guide and facilitate the learning process in order that the learning process is up to the standard. This learning is often called as e-learning. The simple meaning of e-learning is an online access to the learning sources which can be done wherever and whenever. E-learning offers new opportunities for teachers and students to enrich their teaching and learning experiences through a virtual environment that supports not only the materials transfer but also the exploration and application of information and understanding of new knowledge (Widyaningsih et al., 2020; Sholihah, 2012). E-Learning enables learning interaction from wherever and whenever, facilitating refinement and storage of learning materials (Shi et al., 2020; Nisa, Choirun, 2018). One positive side of virtual class is that students are required to be more active than that of traditional classes. Virtual classes also give ways to the student-centered teaching learning system (Student Center learning) and can give positive influences to students' achievement (Ng & Or, 2020).

*Corresponding author.

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Internet can give enrichment and communication between students with lecturers, amid students, or between students with other resources (Paradesa et al., 2010; Sohibun & Ade, 2017). This matches with the interviews and questionnaires given to a lecturer who majors in Mathematics and students who state that there are some advantages of the use of internet. Some of them are: they can access broader materials, ample varied question samples, can increase the depth of the study, and internet can also be comparison resources with those of the lecturers have taught. The widespread use of internet can be significant potency in online learning system development (Yuberti, 2015). One of program study that applies internet-based learning is Informatics Engineering.

The Informatics Engineering Study Program, as one of the education institutions which has a mission to produce future national leaders, undergoes problems in its learning process. This information is based on the observation and interviews with Mathematics lecturers. They said that students could not really absorb/understand learning materials, and did not really participate in the learning process whereas the frequency of the lecturers' attendance was quite high. Learning activity has become unfavorable activity for the students. Their attendance in the class was merely to fulfill the requirement of undergoing SKS (semester credit system) that they have taken in their KRS (study plan card) and the learning process were felt as a bribe of materials. With this psychic condition, the learning process generally feel as more moral burdens than the effort to gain and enrich their knowledge. This study will develop Calculus II teaching material based on virtual classes to increase the students' understanding of Mathematics concept. If it is ignored, it will badly impact the quality of the students produced that will certainly have a bad impact on the achievement of Education Objectives in general.

This is in line with a finding in the previous research that the students' ability to accomplish calculus problems is still low. This is clarified by (Farida & Indah, 2019) finding which stated that in the academic year 2015/2016 up to 2018/19, the calculus 1 score of the Informatics Engineering students at STMIK can be seen as follows: the students who get score below 65 (category C, D, and E) is 59%. (Annajmi, 2020) has also the same findings it found out that based on the assessment conducted in the even semester of academic year 2017/2018, it was proved that the students failed to accomplish the given calculus problems, the percentage of the students who pass with a good grade (A or B) is still very low, which is less than 50% of the total students. To overcome the problem, it is necessary to have learning tools that are in line with technology development. One of the learning tools is learning materials.

Learning materials have an important role as a means to achieve learning objectives and competency demands. Good learning materials can make it easier for the students to understand the materials, create interesting and interactive learnings and the learnings will be more efficient. However, the implementation in Mathematics education is still sluggish including among other things is the provisions of technology-based learning materials for calculus subject (Jiang et al., 2009; Paradesa et al., 2010). Most learning materials are modules consisting of materials and exercises in the form of textual books. On the contrary the innovation of animation-based teaching materials prove to be more effective in improving students' achievement (Novianti Anik, 2018). Therefore, it is necessary to develop calculus teaching materials that are innovative and in line with the education goals and objectives (Anisa, 2018; Shodikin, 2017; Sunismi, 2015). It is expected that the students' calculus achievement will also increase.

In the past some studies have been conducted. The researchers wrote that calculus teaching material development has a positive impact on the achievement and learning material quality. Research conducted by (Annajmi, 2020) found that the average of the whole aspects of the evaluation towards learning material is 4.29. It means that the learning material has been valid. From the analysis result of the practicality questionnaires, the total average is 4.28, which means practical. From the questionnaire result of students' response towards learning materials of learning material aspect component and learning activity, it is obtained that the mean percentage of the total students' positive response is 81.67%, which means that the learning material is effectively used by the students in the learning process.

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Learning material development which is in the form of Calculus practicum guide using maple program is highly effective for the learning process (Andriani, 2012). The students' reasoning and representation skill towards calculus practicum learning material development using program maple increases significantly and is achieved. However, it has not matched the expected indicator. In addition, the students' attitude towards the implementation of Calculus practicum using maple is positive and the students agree on the practicum learning process (Johnsen et al., 2018; Kordzadeh et al., 2016).

The lectures using learning materials and students' tasks, which have been developed by following MPMK stages, are effective enough to increase the students' competency in vector (Dedy et al., 2012; Jiang et al., 2009; Merro et al., 2011). Research conducted by (Farida & Indah, 2019) found PBL-based modules in Calculus 1 lecture has a strong validity both in its construction and content. Module practicality is obtained through observation on lecture implementation and interview result; it is obtained that Calculus 1 lecture module has already been practical and it is easy to use for the students timewise. The effectiveness of the modul in Calculus 1 lecture has been effective based on the learning achievement and the students' activity observation. Research conducted by (Anisa, 2018) stated that there is an increase in the ability to think critically in classes that use the development of teaching materials. Research conducted by (Shodikin, 2017) stated that the end product of this research is animation-based teaching media for the course of integral calculus with development using models of four stages, namely: (1) definition, (2) design, (3) development, and (4) dissemination. Research conducted by (Paradesa et al., 2010) stated that prototype of calculus teaching materials 2 using the macromedia flash and maple developed have a potential effect on learning outcomes. this can be seen from the average value of learning outcomes, namely 81.2 in the very good category, which is 82%.

Based on the advantages that the learning materials and virtual classes have, it is formulated one goal of this study to analyze the validity of virtual-class-based Calculus II learning materials; the effectiveness of the designed learning materials towards the understanding increase of the students' mathematical concept. The difference between this study from the previous is that this one develops virtual-class-based learning materials so that in future it will positively influence to understanding the concept of the informatics engineering students.

2. Method

The method used in this research is the development model of ADDIE (Analysis, Design, Development, Implementation dan Evaluation) (Branch, 2009). ADDIE Model is used to develop learning products that will be used in schools. A study development is a study that focuses on product development, both industrial products and learning products in the school environment that are tested on the field, evaluated, and refined to fulfill effectiveness criterion and quality standard so that they are suitable to be used (Silalahi, 2015).

The research was conducted in UNINDRA in even semester academic year 2019/2020. The subject of this research was the Informatics Engineering students of UNINDRA who took Calculus II; there were 2 (two) classes: an experiment class consisted of 14 students and a control class consisted of 15 students. The study class was determined by using a simple random sampling technique.

Instrument and data collection technique used were in the form of: (1) an observation was used to monitor Calculus II teaching-learning process; (2) a test was used to collect data regarding the students' mathematical concept understanding skill; (3) a questionnaire was used to measure the validity of the learning materials that were developed in the form of students' and experts' response. The validity of learning materials developed was examined by validators in advance. After it had been declared valid, its effectiveness and practicality were tested. The learning material quality developed was categorized to be ready for use if the percentage of the validity result by the validator was in the interval category at least valid enough. Learning material validity criteria can be seen in Table 1.

Table 1. Learning Material Validity Criteria

Interval	Category
85% < percentage Valid ≤ 100%	Very valid
70% < percentage Valid ≤ 85%	Quite valid
50% < percentage Valid ≤ 70%	Less valid
0% < percentage Valid ≤ 50%	Invalid

The test analysis of the learning material effectiveness by using two-tailed test formula with the significance rate (α = 0,05). Normalization gain test (g) was used to measure the number of the students' concept understanding increase before and after the treatment was given in the experiment class.

3. Result and Discussion

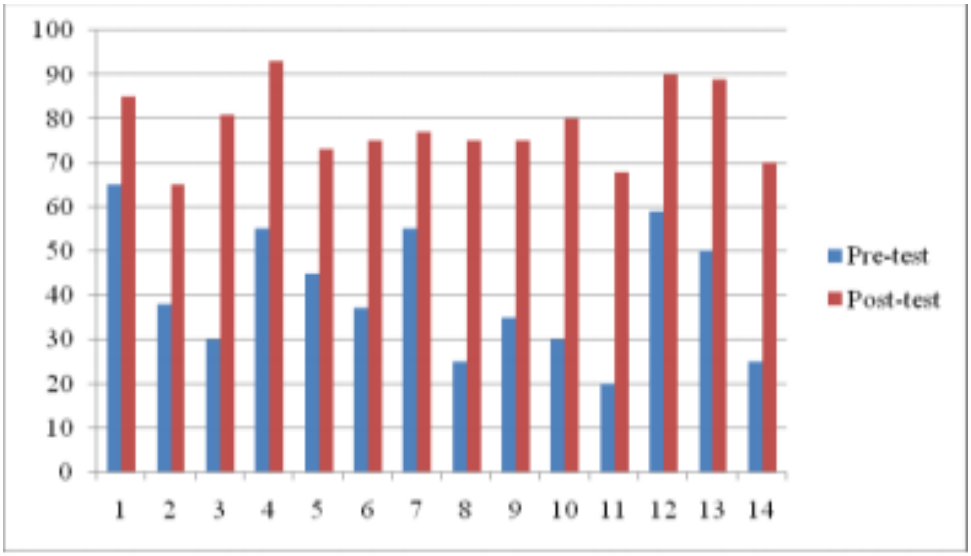
Before the developed virtual-class-based Calculus II learning materials were implemented in the field, their validities were tested by the experts in their expertise. The validity results from three validators can be seen in Table 2.

Table 2. Learning Material Validity Result

No	Validator	Scores (%)
1	Content and Language expert validator	91,23
2	Media expert Validator	88.01
3	pedagogy expert Validator	92,73
	Average	**90,66**

The validity result in Table 2 indicates that the developed learning materials were highly valid because they were in the range of (85% < Pv ≤ 100%). Therefore, those learning materials were good to use. Additionally, from the pre-test and post-test tryout, it can be selected valid and reliable questions so that they are good to use to measure students' concept understanding skills.

The pre-test and post-test result of students' concept understanding skill in the experiment and the control class is presented in Picture 1 dan Picture 2. Concisely, the test result of the concept understanding skill is presented in Table 3.



Picture 1. Experiment Class's Test Result

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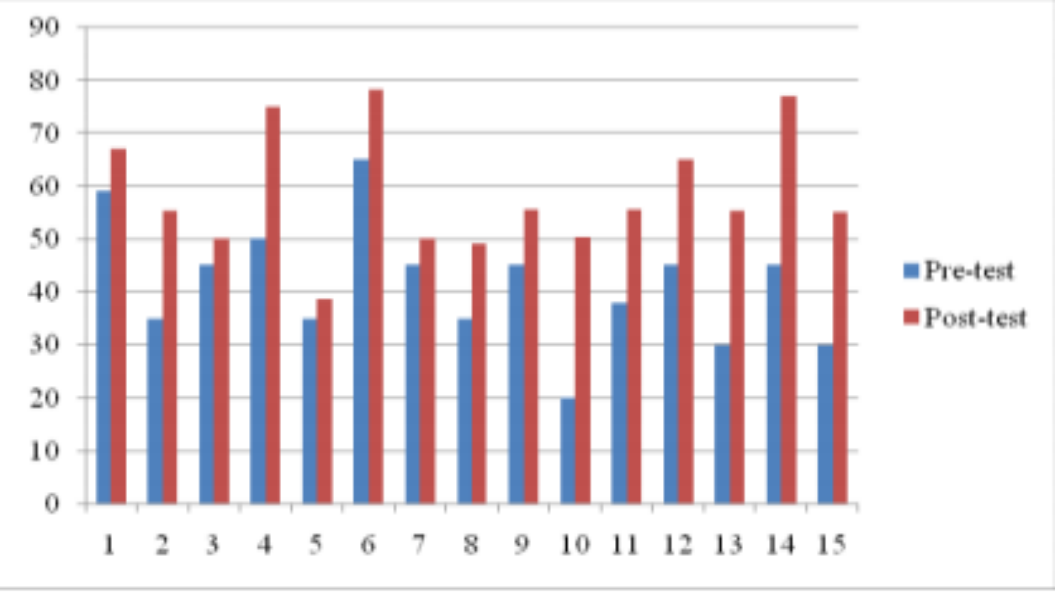

Picture 2. Control Class's Test Result

The following is the test result of the students' concept understanding skill:

Table 3. The Test Result of the Students' Concept Understanding Skill

Statistics	Experiment Class(n=14)		Control Class(n=15)	
	Pretest	Post test	Pretest	Post test
Maximum score	65	90	65	78
Minimum score	20	65	20	39
Average	40,64	78,29	41,47	58
Standard deviation	14,26	8,49	11,52	11,54

Table 3 indicates that the experiment class and the control class undergo concept understanding skill increase with the pre-test score result lower than post-test score. The post-test score average of the experiment class is greater than post-test average of the control class. This shows that the students' concept understanding skill of the experiment class is better than that of the control class. The post-test data standard deviation of the experiment class is less than that of the control class. This shows that each student's concept understanding of the experiment class tends to be homogenous compared to that of the control class.

A follow-up analysis of the virtual-class-based Calculus II learning materials effectiveness towards student's concept understanding skill was conducted using independent sample test t of which normality had previously been tested and the result showed that the sample came from the population that has normal distribution and homogeneity test showed that both study samples are from homogeneous population.

Based on the results of the independent sample t test with $\alpha = 0,05$ obtained t count = 5,254 > t table = 2,045 which means that students' concept understanding skills in learning Calculus II taught using virtual-class-based learning materials were better than those of the students who were taught using different materials. It occurred because those learning materials had been adjusted with the students' characteristics so that the students might put forward all problems they encountered. Other students could also give a solution based on their arguments. There was no time limit for the students to access the learning website that presents the materials in detail and comprehensively in the form of reading materials, practice

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questions, and discussion materials. This result shows that the developed learning materials can help students to understand Calculus II learning concepts. It is in accordance with the study result (Bien et al., 2019) that the learning material development designed impacts on mathematical concept understanding. A similar study was also conducted by (Ng & Or, 2020) that stated that the virtual-class-based learning materials designed have a potential effect on learning achievement.

After we know the learning achievement in the experiment class is better. Next, the concept understanding skill increase number is tested by using normalization gain test and the gain score result = 0.63 which means the students' concept understanding skill in the experiment class increases with the size categorized as medium. The students' concept understanding increase in learning Calculus II because the learning materials developed are based on virtual classes. Students can access the learning materials wherever and whenever. They will also be trained to be more independent in learning. Using virtual class can increase students' learning independence. In addition, virtual-class-based learning materials are also very interactive. It is accordance with the study conducted by (Nisa, Choirun, 2018) that stated that with virtual class e-learning students can discuss, accomplish test statistics with computation, understand statistics concepts via video and reading materials, and interact with lecturers when students encounter problems so that they will be independent. The virtual-class-based learning materials influences learning achievement because students are more active, learning process can be done anywhere and the time can be adjusted to suit students.

With virtual-class-based learning materials, internet is not only used for social media or a KRS activity only. With online learning, students will use the internet wisely because there are many online materials nowadays. A previous research also wrote that (Annajmi, 2020) development found the average of the whole evaluation aspect towards learning materials was 4.29. It means that the learning materials were already valid. Analysis result of practicality questionnaire whole average was 4.28. which means practical. The result the students' questionnaire response towards learning materials from learning material component aspect and learning activity, the percentage of the students' total positive response mean was 81.67%. It means that the learning materials are effectively used by the students in the learning process.

Another similar research is conducted by (Anisa, 2018) which states that the results of using teaching materials in vector calculus subjects are declared valid and effective. This validity is based on fulfilling the content and construct validation set by the experts. Research conducted by (Anisa, 2018) stated that there is an increase in the ability to think critically in classes that use the development of teaching materials. Research conducted by (Shodikin, 2017) stated that the end product of this research is animation-based teaching media for the course of integral calculus with development using models of four stages, namely: (1) definition, (2) design, (3) development, and (4) dissemination. Research conducted by (Paradesa et al., 2010) stated that prototype of calculus teaching materials 2 using the macromedia flash and maple developed have a potential effect on learning outcomes. this can be seen from the average value of learning outcomes, namely 81.2 in the very good category, which is 82%. So, from the explanation above, it is hoped that these findings can contribute to optimizing calculus learning, especially in mathematics learning.

4. Conclusions

Based on the results and discussion, it can be concluded that the teaching materials for Calculus II based on virtual classes are valid and suitable for use in learning and are effective and practical to improve student’s conceptual understanding. Based on the results of the validation of three validators, the contents of the material in the developed teaching materials are in accordance with the learning outcomes of the Calculus II course and the languange used is in accordance with enhanced spelling (EYD). Students’ understanding of the concept after using teaching materials developed in the experimental class was better than the control class which was shown by the post-test average score of the control class.

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