The Instructional Design of Blended Learning on Differential Calculus Using Successive Approximation Model

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Abstract. The combination of traditional learning where teacher and students are in the same classroom and e-learning using technology is known as blended learning. This paper outlines the process of designing blended learning on Differential Calculus. The Successive Approximation Model (SAM) is used as the instructional design upon the course. In the preparation phase, the information gathering is starting to ensure an agreement between the learner's need and learning solution. Afterward, the design and prototype of a blended course was implemented for Mathematics Education students on Mathematics Department Universitas Negeri Surabaya. Along with iterative development phase, the evaluation is conducted in order to make the course move to Alpha (a complete version of the instructional design blended learning) then evolve into Beta (a better version after Alpha revised) and then the Gold as finale version is reached.

1. Introduction

The technological developments in recent years have changed human civilization. Everything that is a product of technology has helped humans in meeting their needs. This happens also in the world of education. One technology product that can be used to help teaching and learning in class is the use of the internet [1]. It does not only help a lecturer to complete the references needed in lecturing but can also use it as a learning medium that bridges the limitations of space and time between lecturers and students on design instructional.

This paper intends to explain the instructional design on Differential Calculus for Mathematics Education students of the Department of Mathematics, Universitas Negeri Surabaya using a blended learning system. This lecture will be held in 30 meetings in 15 weeks with the form of face-to-face and on-line lectures conducted at the Universitas Negeri Surabaya Online Learning System which is integrated with Siakadu (Vi-learn). For this reason, it is necessary to develop teaching materials using information and communication technology. Teaching materials will be delivered face-to-face and through e-learning both off-line and on-line as a blended strategy of learning [2]. The method used in the form of lecturing, independent learning through teaching materials delivered in the form of files, slides, simulations or learning videos and discussions either directly or through information and communication technology. For the assessment of lectures will be evaluated in the form of assignments.
and quizzes. In addition, students are asked to provide responses in the form of input or comments about lectures conducted with this blended learning system.

2. Background Theories

2.1 Blended Learning

Blended learning is an instructional methodology that using technology to provide a more personalized approach to education and to give students control over the time, place, path and pace of their learning [3]. Blended learning is an innovative concept that embraces the advantage of both traditional teachings in the classroom and ICT supported learning including both offline and online learning [4].

The term "blended learning" was used first by Cooney et al. in 2000 to combine elements of play and work in prekindergarten [5]. Today, there are many articles and practices about blended learning using any kind of technology and variant of media.

2.2 Instructional Design

Instructional design is defined as a systematic procedure in which educational or training programs are developed and composed for a substantial improvement of learning [6]. Instructional design contains both scientific and technological theories on the design of learning environments.

The advancement of technology, institutions are able to reach more students than ever with the help of quality and accessible online courses. 'e-learning', ‘distance education’, ‘blended learning’, ‘online campuses,’ and other related programs have grown more prominent in higher education institutions [7].

There are many models of instructional design to facilitate the development of learning system. The abbreviation of Analysis, Design, Development, Implementation, and Evaluation (ADDIE) was a five-phase model that developed in the mid-1970s with the purpose of formalizing the process of developing military inter-service training [8]. There are many other instructional designs such as Dick and Carey, Borg and Hall, Hannafin and Peck, ASSURE, Kemp, Brown, and SAM as a model of initial ADDIE models [9].

2.3 The Successive Approximation Model (SAM)

SAM was introduced by Michael W. Allen in 2012 with the intent of providing increased flexibility with more agile development, responsiveness, and collaborative opportunities than offered by traditional ADDIE [8]. SAM also need collaboration between instructional designer, program manager, facilitator, and students.

![Figure 1. The Phases of SAM (alleninteractions.com/sam-process).](image)

There are three phases of SAM and each could be cycled in order to be the best instructional design that can be represented as Figure 1. SAM starts with the Preparation phase to get information and all background knowledge about objects' needs and ways of solutions. This
phase was usually known as a "Savvy Start" where brainstorming and prototyping of the system were initializing [1].

Then in the Iterative Design phase, the initial prototype will be rotating through a cycle of review-design-prototype again as a project goal meeting. This phase is an emphasis on an iterative approach to creating the right product.

The last phase is Iterative Development with the develop-implement-evaluate cycle work together. This phase will start with design proof to implement then evaluate to get the Alpha design as a complete version of the instructional application. Then the design will evolve into the Beta version after revised based on the Alpha cycle. Finally, it will go into the Gold version after feedback of the Beta step.

SAM allows us to analyze and evaluate throughout the process. At any point, if a change needs to occur, it can happen quickly to limit any risk of moving out budget or time [10].

3. Methods
SAM starts with the preparation phase where information and all background knowledge are gathered. The characteristics of the student must be considered. Differential Calculus lectures with blended learning systems are delivered face-to-face and e-learning using both offline and online. The Lesson Plan (Rencana Perkuliahan Semester or RPS) was prepared in advance based on the description of Differential Calculus courses in 30 meetings for 15 weeks. These steps are recalled as a Savvy Start in the SAM model.

The next phase, based on the RPS a storyline is made at each meeting so that the lecture can be determined face-to-face, off-line or on-line as well as the type of media required. This storyline will be validated by media experts to determine the suitability of media used. After the storyline is declared valid the content output will be made then validated by the material expert to find out the validity of the Differential Calculus material content. These works are carried out in the framework of making a prototype then reviewing.

In the Development phase, the reviewed prototype would be implemented for one class of Mathematics Education at Mathematics Department of Universitas Negeri Surabaya use online system (Vi-learn). Data analysis techniques to evaluate will be carried out by:

a. Every process in the research method has been carried out, otherwise, there must be an alternative step taken or there is a relevant reason that does not affect the lecture process.

b. Differential Calculus lecture using blended learning is said to be able to use by students if the average score of Assignments and Quiz students above the passing grade of a course i.e. 56. Student responses after attending Differential Calculus lecture using blended learning is said to be positive if the percentage of positive responses is more than 50%.

If all the above criteria are fulfilled, then it can be considered as Alpha version of Blended Learning Differential Calculus.

4. Results
Calculus Differential is the first part of Calculus lesson that gives to the new enrollment student from fresh high school graduated. Being involved as a university student, they should adapt to learning behavior from teacher-centered to student-centered. Although most students are used to using gadgets, they rarely used them for learning.

Based on these findings and RPS of Differential Calculus, we arrange a storyline to make a prototype of blended learning. Then we implemented blended learning of Differential Calculus on Vi-learn (https://vi-learn.unesa.ac.id/course/view.php?id=3361). One of the online parts of this course can be presented in Figure 2.
The blended learning of Differential Calculus was delivered for 2019A class that taken by 40 students. The first meeting happened on August 19th, 2019, and the next will be held every Monday at 10.20 - 12.00 and Friday at 13.00-14.40.

In every meeting, there are some materials, video, and assignment can be found. Student responses are pretty good because they can access Vi-learn even through smartphones. Students can also chat and upload the results of their work on the given assignment. However, the video uploaded is not loud enough if heard via smartphone. It should be improved for the next video.

SAM model allows us to make a review and revised even change teaching methods and media used. Based on the students' responses as depicted in Figure 3, 36% students feel passive in learning because all the material has been provided.
In this case, we try to give some assignment or activities not only in face-to-face but also on Vi-learn as show in Figure 4 that we conduct a live chatting to discuss about domain.

![Live chatting to discuss about domain](image)

**Figure 4.** Live chatting to discuss about domain.

5. Conclusion

As a beginning of instructional design on Differential Calculus course using blended learning, it showed that a fairly good development. It is expected with the use of SAM model for instructional design will be produce the blended learning of Differential Calculus that are appropriate to the learning purpose and students’ requirements as Alpha version.

For the future works, it could be increased until Beta version and up to Gold version as an e-learning course in SPADA (Sistem Pembelajaran Daring Indonesia), an Online Learning System in Indonesia.

Acknowledgment

The authors would like to thank Universitas Negeri Surabaya upon the foundation of this research via PNBP.

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