

Developing an interactive digital book to improve the technical drawing abilities of mechanical engineering students

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ABSTRACT: The aim of this study was to develop an interactive digital book and assess the validity and effectiveness of it. A 4D development model was created consisting of four stages: a) define; b) design; c) develop; and d) disseminate. Product validity was confirmed by experts' material in technical drawing (the material), as well as by media experts. The effectiveness of the product was assessed through a post-test control/experimental group design with two mechanical engineering student groups totalling 45 students. Data collection was done through observation, questionnaire and tests. Validation by experts of the material and media showed that the interactive digital book was very good and appropriate to use. It was also concluded that, in terms of product effectiveness, the use of the interactive digital book had a significant positive effect on student technical drawing ability. These findings showed that an interactive digital book could be used as one of the innovative learning media to improve students' ability in technical drawing.

Keywords: Interactive digital book, technical drawing ability, engineering student, 4D model

INTRODUCTION

Computer and information technology have greatly affected society and education [1]. An example from education is the application of interactive multimedia to increase the interest and motivation of students [2]. Integrating technology into learning provides opportunities for the students to obtain essential lifelong learning skills [3].

There are several characteristics of effective learning [4]:

- 1) active learning by students, both mentally and physically;
- 2) learning methods and media to attract students' attention and provide an active environment in the classroom;
- 3) highly motivated teachers.

Cloonan's research found that in traditional lecturing, the highest level of attention of the student takes place only in the first 10 minutes or at the end of the learning session. The use of innovative learning media to more fully engage students can improve the learning for both teachers and students [5].

Nowadays, learning media is more varied and innovative with information technology-based interactive learning media. As Sumadji stated, technological support for learning is an effective and efficient way to deliver information [4]. Teachers and lecturers recognise the positive effects of information and communication technology in education. It helps to change the paradigm for learning in Indonesia, from teacher-centred learning (TCL) to student-centred learning (SCL).

Multimedia can be defined as technology that combines high quality sound, images, video and text [5]. The use of multimedia can improve the quality of learning in the classroom. Some research results show that multimedia-based learning can significantly increase activity, interest, participation and creativity of students as compared with traditional learning methods [6]. Learning through multimedia is able to improve students' performance and academic achievement [7][8]. Several studies have found that interactive multimedia in learning can improve critical thinking skills, as well as character development in students [9][10].

Technical drawing is one of the compulsory competencies for engineering students, especially those studying mechanical engineering. This competency relates to a student's spatial abilities and the ability to project the construct of

shapes as a technical communication tool [11]. The Technical Drawing course covers the mastery of two-dimensional and three-dimensional graphic presentation techniques through construction, orthographic drawing, isometric projection, perspective and the mastery of graphic presentation rules of standardisation, notation and technical drawing rules [12].

The description above indicates some of the benefits of using multimedia to improve quality of learning in the classroom. This encouraged the authors to:

- 1) develop multimedia learning in a form of an interactive digital book for the Technical Drawing course;
- 2) test the feasibility of the product based on expert validation;
- 3) assess the effectiveness of the use of the interactive digital book to improve students' ability in technical drawing.

METHOD

The objective of this study was to develop instructional media in the form of an interactive digital book for a Technical Drawing course. According to Sugiyono, research and development is used to produce a product and to test its effectiveness [13]. The development item in this study was the 4D model from Thiagarajan, which consists of four steps; namely, define, design, develop and disseminate [14]. Software for the product development was Kvisoft FlipBook MakerPro. The flow of the 4D model development is shown in Figure 1.

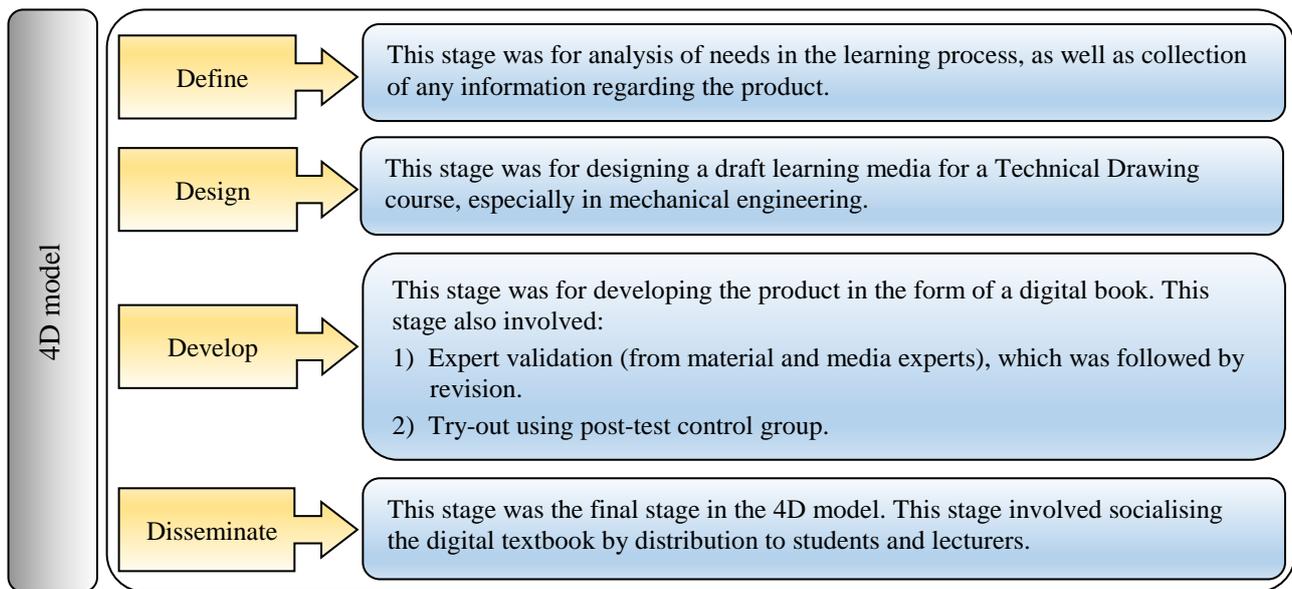


Figure 1: Digital book development with the 4D model [14].

In this study, the data were collected through questionnaire and test. The questionnaire, with a Likert scale of 1-5, tested the validity of the product based on expert validation [2]. The test measured the effect of the interactive digital book on the students' ability in technical drawing. A post test-only control group featured in the research. This experiment design involved 45 mechanical engineering students who were divided into two groups, as a control group and an experimental group.

Data analysis in this research was done through descriptive and inferential analysis. Descriptive analysis was used to analyse data from the results of product validation by material and media experts. Inferential analysis tested the research hypothesis. An independent sample *t*-test was used with a significance level *p* of 0.05 (5%). Analysis was carried out through SPSS version 22 software.

The product was assessed on a Likert scale of 1-5 [15]: 1) excellent; 2) good; 3) average; 4) poor; and 5) very poor. To determine effectiveness of the product, the null hypothesis H_0 that there was no effect of the product on technical drawing was tested through an independent sample *t*-test. H_0 would be rejected if significance (sig.) was less than 0.05 (5%), in which case, there was a significant influence of the use of the interactive digital book on technical drawing.

RESULTS AND DISCUSSION

Define Stage

This stage was carried out in several steps; namely,

- 1) Front-end analysis: based on the mechanical engineering curriculum, the objectives of this course was for students to communicate and make graphic images, and to communicate these through the norms and standards of applied technical drawing. The course covers two- and three-dimensional graphic presentations, orthographic drawings, isometric drawing, perspective, standard rules of graphic presentation, notation and technical drawing rules [12].

- 2) Student analysis: by reference to the index of achievement score (IP) of the students in the Technical Drawing course.
- 3) Concept analysis: the main concepts to be learned arranged systematically in the form of a concept map.
- 4) Task analysis: module development was accompanied by test questions and drawing tasks to understand students' mastery of concepts and drawing skills.

Based on these steps, the authors concluded the need was to develop learning media in the form of an interactive digital book specifically for the Technical Drawing course, which aimed to improve the students' ability in technical drawing. The collection of references and determination of materials for the book were based on the curriculum and description of the Technical Drawing course.

Design Stage

This stage was the design of the book to be developed. The process of developing the digital book was adopted from Pradani and Aziza [16] and is shown in Figure 2:

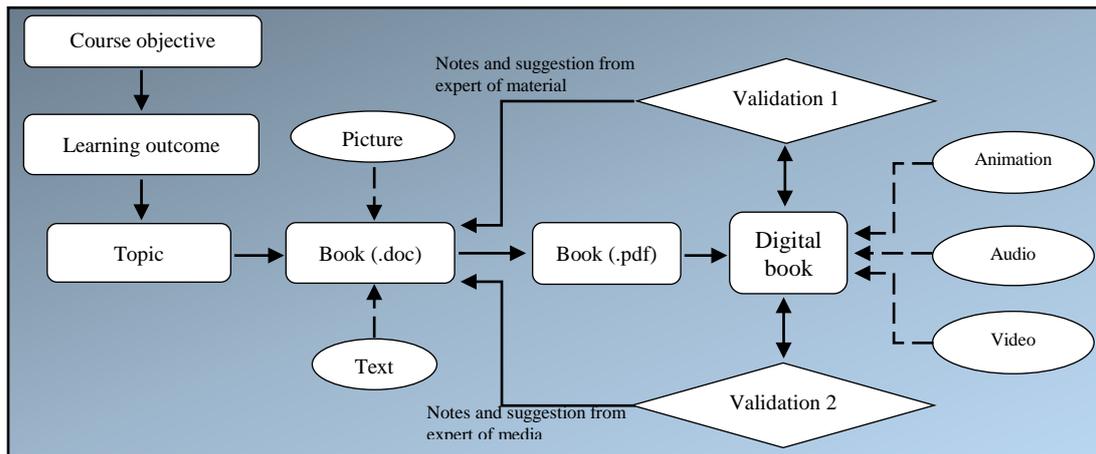


Figure 2: Digital book development.

Figure 2 above shows the process of interactive digital book development. After analysing the problem and needs, the development of the book was also done referring to the curriculum of the study program and the Technical Drawing course description. This covered course objectives, learning outcome and the scope of the topics. The book was compiled with several computer programs including MS Office Word, Adobe Reader XI and Flipbook Maker. The digital book was then validated by material experts and also media experts to assess feasibility of the product.

Development Stage

The result of the interactive digital book development is shown in Figure 3:

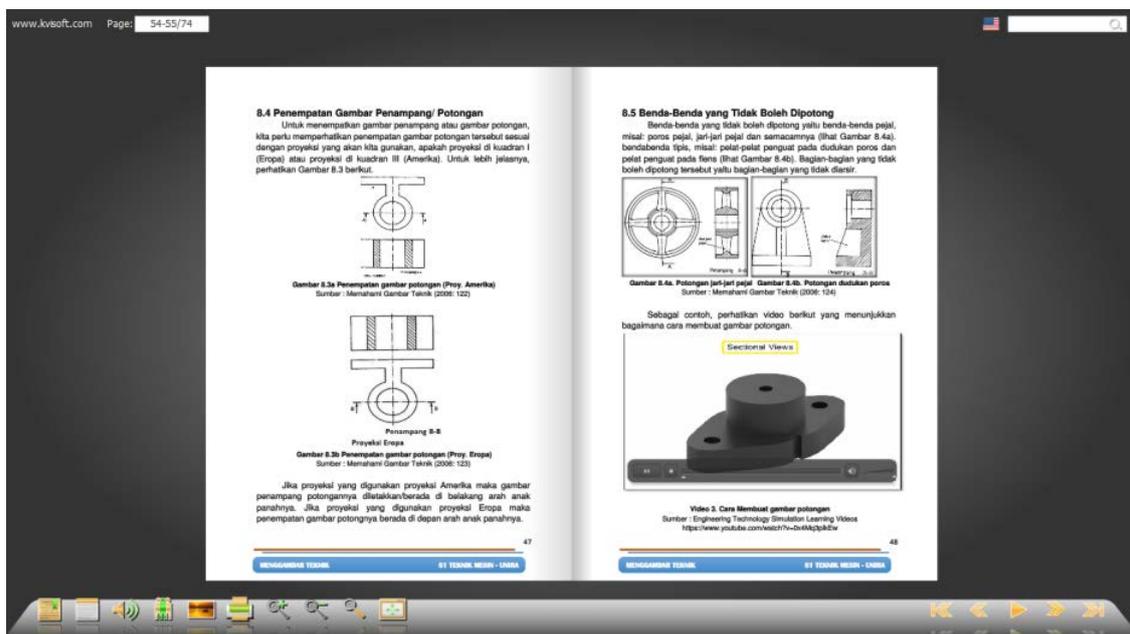


Figure 3: Layout of the interactive digital book.

Presented in Figure 3 is the digital book developed for the Technical Drawing course. The digital book was more interesting and interactive, because of the flip effect between pages. In addition, this digital book was equipped with images, graphics, audio and video making the material easily understood. The digital book was easy for readers to use, because it was equipped with several navigation buttons, such as bookmarks, zoom in, zoom out and search.

Test of product validity was carried out with a questionnaire to be given to experts of the material and media to assess the level of product appropriateness. The results of the assessment by experts is shown in Table 1.

Table 1: Result of material expert validation.

Validator	Indicator	Score
Material experts	Content appropriateness	4.5
	Accuracy and comprehensiveness of the material	4.2
	Suitability with SCL method	4.2
Mean		4.3
Media experts	Layout and language	4.4
	Presentation of picture/graphics and animation	4.4
	Principle of multimedia	4.5
Mean		4.43

In Table 1 are the results of product validity tests by experts of the material and media. The results of the validation by the material experts showed an average score of 4.30, which was in the excellent category. In addition, the validation by media experts gave an average value of 4.43, which was also in the excellent category. The experts agreed that this interactive digital book presented a fairly complete content of technical drawing material, and the interactive multimedia was acceptable and suitable for learning activities.

In addition to the result of the validation, some suggestions by the experts were: 1) each chapter needed additional introductory material that explained the learning objectives and topics to be studied; 2) the exercises or assignments must be adjusted to the learning objectives presented in each chapter; and 3) it was necessary to directly assess the students to determine effectiveness of the digital book in improving student learning outcomes, especially in the Technical Drawing course. Thus, the interactive digital book was appropriate to try out on the students.

The effectiveness test of the digital book was carried out with two student groups: control and experimental. The researchers conducted an experiment with a post-test control design, which aimed to determine the effect of the interactive digital book on students' technical drawing ability. The data analysis technique was an independent sample *t*-test. Figure 4 below showed the students' ability in technical drawing from randomly selected students divided into the control group of 23 and the experimental group of 22.

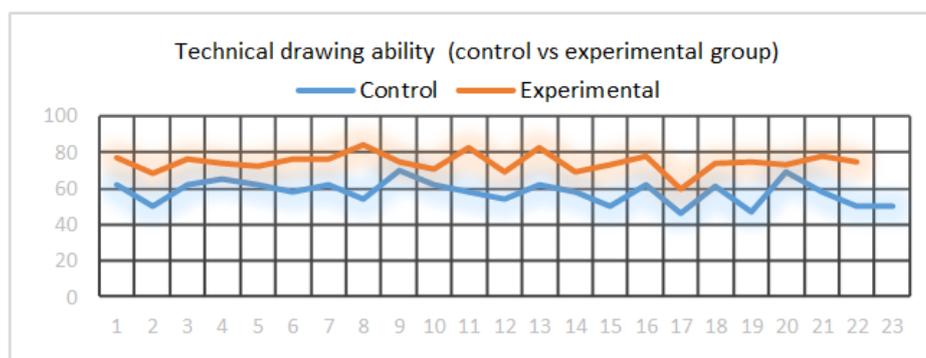


Figure 4: Students' technical drawing ability.

Figure 4 above showed the technical drawing ability of students in the control group and experimental group. The control group obtained an average value of 57.88, standard deviation of 6.64, lowest value of 56.20, and highest value of 70.20. On the other hand, the experimental group obtained average value of 74.97, standard deviation of 5.32, lowest value of 59.40 and highest value of 84.20.

Before testing the hypothesis with an independent sample *t*-test, it was necessary to do prerequisite normality and homogeneity tests. The data normality was determined with the Shapiro-Wilk test, because the sample was less than 50. The Shapiro-Wilk value for the control group was 0.940 with sig. = 0.180 and the Shapiro-Wilk value for the experimental group was 0.931 with sig. = 0.127. Because of sig. > 0.05 it could be concluded that the data from the two groups were normally distributed. For the homogeneity test, the Test of homogeneity of variances showed a sig. value of

0.150, greater than 0.05. Therefore, it could be concluded that the data variance of the two groups of students was homogeneous.

After the prerequisite tests, hypothesis testing was carried out to find out the differences in the average ability of technical drawing between the control and experimental groups, by using an independent sample *t*-test. Table 2 shows the test results.

Table 2: Analysis result of independent sample *t*-tests.

Group	N	SD	Mean	<i>t</i> -test sig. (2-tailed)
Control	23	6.64	57.88	-9.501 (0.000)
Experimental	22	5.32	74.97	-9.548 (0.000)

Based on Table 2, the sig. of 0.000 was less than 0.05, which means there was a significant (real) difference between the technical drawing ability of the control group and the experimental group. The learning process with the interactive digital book can increase students' interest in reading and motivation, thus shaping them to be more active and independent learners [6]. The technical drawing ability of the experimental group was significantly higher than the control group. This finding indicated the use of the interactive digital book had a significant effect and improved students' technical drawing ability.

This finding is in line with the research conducted by Hamidah et al who found that multimedia-based teaching material is effective in increasing students' conceptual understanding of learning material about heat transfer [17]. The research also found that the use of multimedia can create a more enjoyable learning experience and facilitate students to independently master the concepts studied. Therefore, educators (teachers or lecturers) should design and develop innovative learning resources suitable for the students, by following developments in information and communication technology (ICT) [18].

Disseminate Stage

Based on the validity and effectiveness test of the product, it was considered that the interactive digital book had a significant effect on ability in technical drawing and was suitable for use as one of the learning media in the learning process. For this reason, this interactive digital book can be distributed for wider use, especially in the mechanical engineering study programme.

CONCLUSIONS

Based on the results of this research and development, it can be concluded that: 1) this research produced a product in the form of an interactive digital book, especially for the Technical Drawing course; 2) validation by experts of material and media showed that this interactive digital book was very good and could be used in the learning process; and 3) the try-out showed that the application of the interactive digital book could improve students' technical drawing ability. These findings can be input to educators (both teachers and lecturers) to make innovations in the teaching and learning process. One of the innovations is the development and use of instructional media or interactive multimedia to improve students' technical drawing ability.

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BIOGRAPHIES



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