Development of Digital Book in Enhancing Students' Higher-Order Thinking Skill

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Abstract. During the Covid-19 pandemic, the learning process is carried out massively from home, on the other hand, higher-order thinking skills (HOTS) remain a priority for learning objectives, therefore it is necessary to ensure creative solutions to achieve it. Digital book is a learning media that is compiled by combining: 1) text, 2) animation, 3) audio, 4) video, which can be accessed easily and systematically via online. The development of this book aims to facilitate online learning during the covid-19 pandemic, then specifically to measure the level of validity, practically, and effectiveness in increasing students' HOTS. This research was conducted in five stages: 1) analyzing, 2) designing, 3) development, 4) implementation, and 5) evaluation (ADDIE model), while the instruments used were observation sheets, validation sheets, questionnaires, and essay tests. This research was conducted in class E and F, each consist of 35 students. The results of data analysis indicate that this book is in a valid and practical category. Furthermore, this book is very effective to be used to enhance student HOTS.

1. Introduction

The transmission of Covid-19 has been increasing worldwide. The World Health Organization (WHO) determined it is as a pandemic that can endanger human health [1]. This challenge causes changes in daily life activities, especially in learning systems, from face-to-face to online systems. In addition, higher order thinking skills remain as a main goal of the government [2]. Therefore, we need a learning resource that can be used online to improve students' higher order thinking skills.

Online learning is a learning process that is carried out systematically using audio, video, and chat via the internet network. Where this system requires planning and effective learning resources [3], which can be implemented in two methods: asynchronous online teaching, 2) synchronous online teaching [4].

Higher order thinking skills are a thinking competency that is not only at the level of remembering and understanding, but is more complex. The characteristics of this ability are non-algorithmic, complex, find many alternative solutions, multiple interpretations, full of meaning and impressions [5]. HOTS is a skill of critical thinking (analyzing and evaluating), creative (formulating, planning, and producing) [6, 7] and problem solving [8]. To improve it requires: 1) providing real problems, 2) carrying out an investigation process, 3) a discussion process [9].

HOTS is a very urgent skill to be able to solve complex problems systematically and accurately. On the other hand, based on the results of interviews with 20 students from two different classes, it can be concluded that they have some difficulties to solve HOT-based problems. Then, the diagnostic test

results show that only 25% of students are able to solve HOT questions. Furthermore, the data reveal that Indonesian students are still in an unsatisfactory rank in completing PISA (Program for International Student Assessment) and TIMSS (Trends in International Mathematics and Science Study) questions. Therefore, it requires alternative solutions to increase it.

One of the factors causing the low quality of learning is that the books used are not relevant to use in online learning system. Therefore, it is necessary to update it with the latest innovations and current technology. Meanwhile, the development of computer technology has led to changes in the learning process from manual systems to automatic systems, paper to software, physical facilities to network forms. The interaction between lecturers and students is not only face-to-face, but also via online media.

In line, computer technology has three main functions in learning activities, as: 1) tools, 2) science 3) materials (literacy). This technology has been developing rapidly which can be optimally utilized to improve the quality of learning. Therefore, the use of digital books during the learning process is believed to improve students' higher order thinking skills. Because digital books have several advantages: simple, flexible, and practical [10], thus they can stimulate users to learn [11-12].

The learning process should use devices that are integrated with technology in order to visualize geometric images accurately and precisely [13-14]. Video, audio, animation, and interactive quizzes on digital books can be used to visualize mathematical material that is difficult to explain with text, images, or conventional media. Visualization in digital books is a dynamic 2D and 3D animation. Both of these can be used to present mathematical concepts in an effective, expressive, and systematic manner.

Using digital books, the learning process becomes more interactive, inspirational, challenging, and can motivate students to participate in the learning process. In line with constructivism learning theory, learning is an attempt to provide meaning by learners to their experiences through assimilation and accommodation which leads to the formation of their cognitive structures [15]. Therefore, the use of digital books can improve learning independence, understanding of mathematical concepts [16] and higher-order thinking skills.

The second factor, linear programming books available in the market are designed only as a source of information, which consists of theory, formulas, examples, and exercises. This book has not been developed to increase student HOT. Conversely, the books required are those developed based on constructivist theory, where students will construct their own knowledge, through the process of hypothesizing, analysing, synthesizing, researching, improving, and creating.

2. Research Methods

This type of research is research and development, is a systematic study to develop, design and evaluate programs and processes. Where the results must meet the criteria of consistency and effectiveness internally [17]. The development procedure is based on the ADDIE development model. The subjects of this research were students of Mathematical Education UNIMED class E and F, each consisting of 35 people. The object of this research is a digital book from a linear program.

Types of data are qualitative and quantitative. Data obtained through observation, interviews, questionnaires and Hots-based tests. In this study, interviews were conducted with students and teachers to determine the obstacles experienced during the learning process. Observations were made to determine the learning process in detail. Questionnaires are used to determine student and teacher responses and to collect data regarding experts' assessments of digital books.

In this study, there are three types of tests, namely: a diagnostic test that is useful for identifying HOTS. Furthermore, pretest and posttest questions were carried out to determine the level of increase in student HOTS. The trial design used in this study was the One-Group Pretest-Posttest Design. This design can be described as P_1XP_2 [18]. Where: P_1: pretest, X: treatment, and P_2: post-test.

The instruments used in this study were digital book validation sheets (material and media experts), lesson plan validation sheets, student response questionnaire validation sheets and test validation sheets.

The data analysis technique in this study is divided into two: 1) qualitative data analysis techniques and 2) quantitative data analysis techniques. Qualitative data were obtained from the process of interviews, observations and suggestions from teachers, students and from media and material experts. Furthermore, it was analyzed descriptively. Meanwhile, quantitative data were obtained from the results of the pretest-posttest and response questionnaires after using the digital book.

The products were analyzed based on the criteria of Nieveen [19], namely: analysis of validity, practicality, and effectiveness. The validity process of digital books, lesson plans, and teacher and student response questionnaires refer to Adriansyah [20]. The feasibility data analysis technique uses a score from a Likert scale. The practicality analysis was obtained through the results of the teacher and student response questionnaires given after the trial. The practicality analysis is calculated using the following formula:

$$Vp = \frac{TSEp}{S_{max}} \times 100\%$$

where: V_p: practicality validity; $TSEp$: total score of empirical practicality; S_{max}: maximum score. Furthermore, to describe Vp the following criteria are used:

Table 1. Practicality criteria

Criteria	Category
76% - 100%	very practical
51% - 75%	practical
26% - 50%	less practical
0% - 25%	impractical

Furthermore, the effectiveness of digital books can be seen based on the results of the HOTS test analysis, namely the pretest and posttest and student response questionnaires.

The improvement of competency is calculated by the formula g factor (N-Gain), the results are then interpreted using Hake's classification in Meltzer [21].

Table 2. N-Gain classification

N-Gain	Category
g > 0,7	High
0,3 ≤ g ≤ 0,7	medium
g < 0,3	Low

This study is successful if it meets 1) the validity of the product is in the feasible category (3.1> x≥2.5) or very feasible (x≥3.1), 2) practicality (the results of the teacher and student response questionnaires) are in the practical category (51% - 75%) or very practical (76% - 100%) 3) effectiveness if there are at least 80% of students who get A or B grades, and the average N-gain is g> 0.7 or are in the high category.

3. Results and Discussion
Results of this study are described as follows:

3.1 Analysis
Based on the results of the HOT ability diagnostic test of students, there were 14% in the very low category, 29% in the low category, 40% in the medium category, 11% in the high category and 6% in the very high category. Furthermore, based on the results of questionnaires and short interviews, most students admitted that they had not been able to find a book as an effective, practical and systematic learning resource to improve HOTS in the online process during the Covid-19 pandemic. In addition, they admit that it is difficult to learn if they only use the zoom and LMS provided by the campus. They claim to need an integrated interactive media between perceptions, materials, exercises, and evaluations that are systematically arranged which can be accessed online. In addition, based on needs analysis, animation, video, audio, and interactive quizzes are needed to simulate several topics in the linear programming course.

3.2 Designing

Based on the results in analyzing, it is necessary to design a digital book, a lesson plan, HOTS-based evaluation questions, validation instruments and response questionnaires. Digital books are designed according to the characteristics of the material and students. Where this book is composed consisting of text, video, audio, and animation.

3.3 Development

The development of this book is carried out in two stages: 1) preparation of instruments and digital books and 2) validation

3.3.1 Development of instruments and a digital book. At this stage, the questionnaire, test, and lesson plans were prepared based on the concepts and learning theories used. In addition, pictures, videos, animations, audios, interactive quizzes, and materials were prepared to compile a digital book. The materials were developed based on the learning objectives and adjusted with the results of the analysis of needs, materials, and resources. This book was developed in an authentic and contextual way to make it easier to understand. The following was an overview of the linear program digital book (draft I) being developed.

Figure 1. Digital table of contents

A table of contents developed digitally. Where the page number in the table of contents is directly linked to the book page. The user can click the page number on the table of contents to go to the specific page as needed.
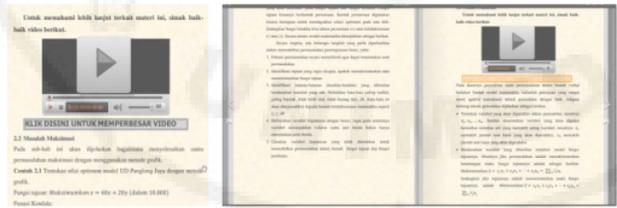

Figure 2. Video feature on digital books

Each chapter of the digital book is equipped with at least one video and animation showing problems and explanation of the concepts. In order to the abstract concepts become more real and easier to understand.

Figure 3. Digital-based interactive evaluation

This book was developed with HOTS-based interactive quizzes, they can solve these problems with a simulation system, where the scores will appear automatically after completing them, so that they can identify their own HOTS levels accurately and systematically.
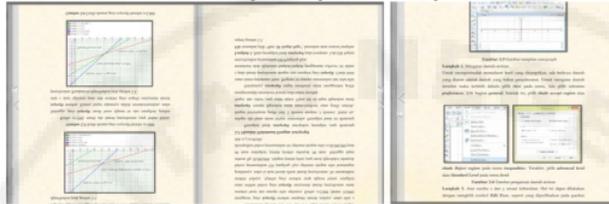

Figure 4. The pictures on the digital book

This digital book contains pictures that aim to illustrate concepts to make it easier to imagine abstract materials.

3.3.2   Expert Appraisal. At this stage the first draft was validated by three experts. The results of the validation show that the mean value of the learning plan and digital book validation is 3.14 and 3.4, respectively, this score is included in the valid category and is very feasible to be used. Furthermore, the mean results of the pretest and posttest instrument validation are 3.62 and 3.43, respectively, this score stated valid with the very feasible category. Subsequently, several minor revisions were made to the ambiguous typing and grammar mistakes.

3.4 Implementation

The revision of draft I resulted in draft II. Where this draft II can be used in field trials to evaluate its practicality and effectiveness.

3.4.1   Readability testing. At this stage the digital books and test instruments are evaluated for their legibility by 6 students. The results show that the two devices developed are mostly clearly readable and understandable. There are minor improvements on chapter 4 pages 108-110. After revising, draft III is ready to use for field trials.

3.4.2   Field trials. At this stage these devicesareused to the trial for six meetings. Then obtained data about the results of the pretest, posttest, student and teacher responses, which are used to determine its practicality and effectiveness.

Practicality criteria are obtained through the results of student and teacher assessments of digital books.

Table 3. The results of the analysis of student response questionnaires to digital books

Number of students	35 students
Percentage of practicality	91.7%
Category	very practical

Based on table 3, it can be seen the students give positive responses to digital books. Where the percentage of student responses is 91.7% of 35 students, which is included in the very practical category.

Table 4.The results of a questionnaire analysis of lecturers' responses to digital books

Number of lecturer	1 person
Percentage of practicality	92,3%
Category	very practical

Table 4 shows that the lecturer gives a positive response to the digital books. Where the results of the questionnaire show that this book is included in the very practical category, with a score of 92.3%.

This digital book is effective if: (1) at least 80% of students get A and B grades, (2) and the N-gain score is in the high category.

Table 5. Percentage of student learning completeness

Interval	Grade	Pretest		Posttest	
		Number of students	Percentage	Number of students	Percentage
90 - 100	A	2	6%	10	29%
80 - 89	B	9	26%	19	54%
70 - 79	C	16	46%	6	17%
00 - 69	E	8	23%	0	0%
Total		35	100%	35	100%

Table 5 describes that there are 32% of students who get grades A and B at pretest, and it has increased to 83% at posttest. It means, there is an increase of 51% of students who get grades A and B.

Table 6. Results of HOT ability level in field trials

Interval	Category	Pretest		Posttest	
		Number of students	Percentage	Number of students	Percentage
90 – 100	very high	2	6%	10	29%
80 – 89	high	9	26%	19	54%
65 – 79	moderate	16	46%	6	17%
55 – 64	low	0	0%	0	0%
0 – 54	very low	8	23%	0	0%
Total		35	100%	35	100%

Table 6reveals that there are 32% of students who obtained grades B and A (high and very high categories) at the pretest, then increased to 83% at the posttest. It means, there is an increase of 51% of students in the high and very high categories.

Table 7. The results of field trials regarding the improvement of hot's ability in the form of N-gain

N-Gain	Category	Number of students	Percentage	Average of gain
$g > 0,7$	high	18	51%	
$0,3 \leq g \leq 0,7$	moderate	17	49%	0.711
$g < 0,3$	low	0	0%	
Total			100%	

Table 7 describes that there are 18 students in the high category, and 17 students in the moderate category. Where the average N-gain is 0.711 which is included in the high category. Based on results of data analysis, it can be concluded that draft III met the effectiveness criteria

3.5 Evaluation

At this stage the errors and deficiencies that occur during the research process are analyzed and then used as material in improving the developed device.I n general, there were no significant errors during the development and trial stages, but the use of time during the trial was 7 minutes more than the set duration. In addition, there are several typing errors in digital books.

4. Conclusion

The results of the study describe that the digital books meet the validity criteria in the very feasible category. Furthermore, the results of field trials also meet the criteria of practicality and effectiveness. After using this digital book there is a dramatic increase in higher-order thinking skills. Finally, the

researcher strongly recommends using this linear program digital book in online learning to increase students' HOTS.

Acknowledgment

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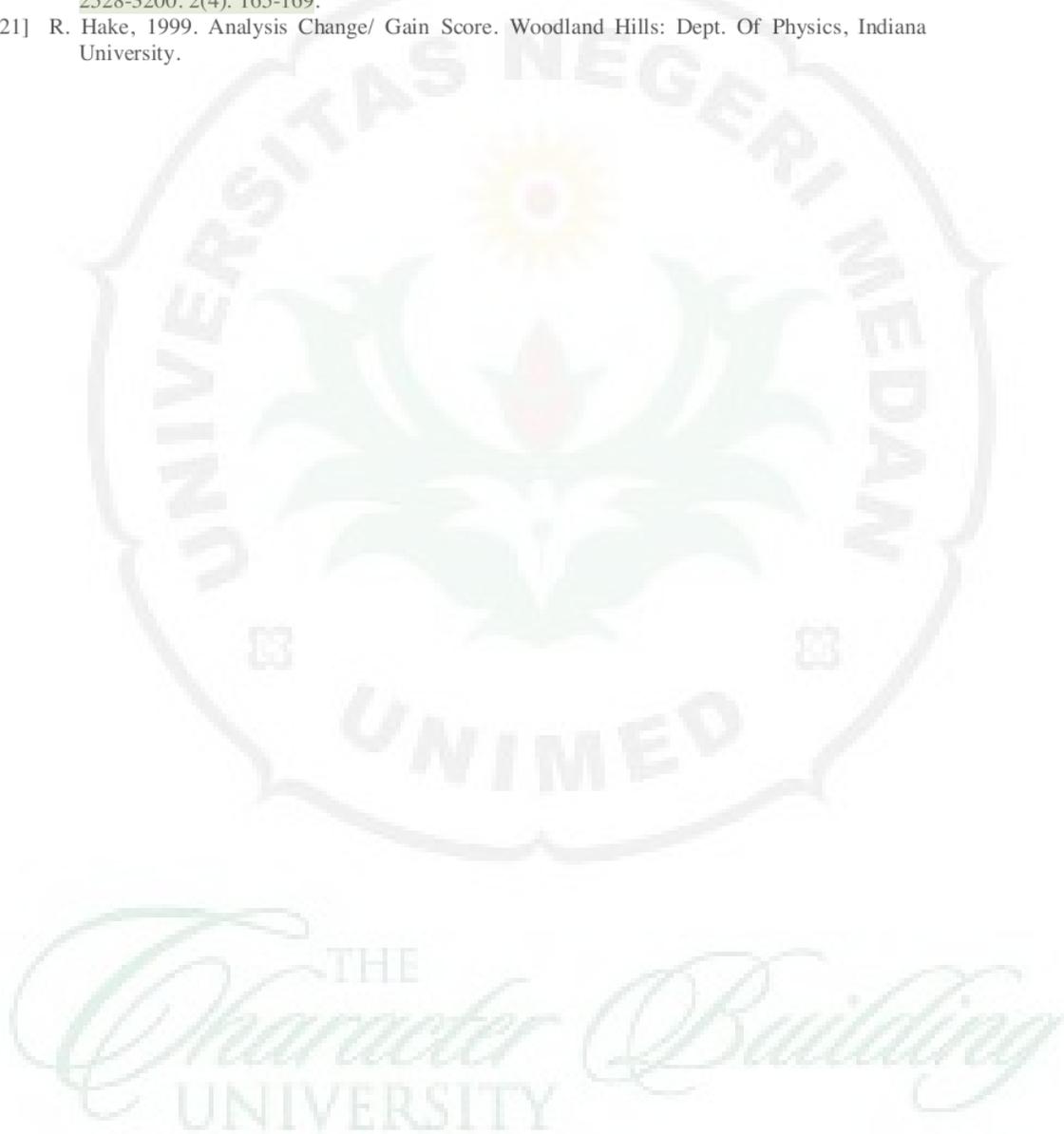
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