Development of Interactive Digital Physics Book Based on Case Method-Differentiation: Design and Validity

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Abstract. The study aims to develop and evaluate the effectiveness of an interactive digital book that utilizes the Case Method-Differentiation principle using the Google Site web platform. In the context of physics learning, the interactive digital book will be designed with the integration of relevant case studies and differentiation options to adjust the level of difficulty of the task. Google Site was chosen as the development platform to facilitate easy access and online collaboration. The design of the digital book is expected to increase student engagement, facilitate understanding of physics concepts, and provide flexibility in accommodating diverse learning needs. Evaluation will be carried out through qualitative and quantitative analysis to assess the level of success of the implementation of this digital book in improving physics learning at the secondary school level. The results of the study indicate that the Case Method-Differentiation physics teaching material using the Google Site web platform is feasible to use in learning. The study is expected to provide insight into the effectiveness of using the web platform and differentiation approach in developing innovative physics teaching materials.

Keywords: Interactive Teaching Materials, Case Method-Differentiation, *Web Google Site*.

1 Introduction

The Independent Curriculum is a curriculum with diverse intracurricular learning where the content will be more optimal so that students have enough time to explore concepts and strengthen their competencies [1]. When viewed from a philosophical aspect, independent learning is based on humanism and constructivism, meaning freedom for students to determine knowledge and learning choices and must be able to provide benefits to life in their surrounding environment [2]. The Independent Curriculum is an educational innovation that aims to improve the quality and relevance of education by integrating freedom, innovation, and students' ability to adapt [3].

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Adapting content according to the diversity of characteristics is often known as differentiation. Differentiation can basically be interpreted as a form of teaching adjustment to meet the special needs and learning styles of students [4], [5]. Differentiated learning aims to create learning equality for all students and bridge the learning gap between high achievers and low achievers. In short, differentiated learning is a learning process that is designed in such a way that students feel challenged to learn [6], [7]

The learning challenges expected from students are not only to increase the willingness to learn, but must be able to improve students' creative and critical thinking skills. Thus, the differentiation approach is not enough but must be equipped with a case method in order to stimulate students to think creatively and critically. The case method should be able to reduce the gap between theory and practice, be able to provide a complex and contextual learning experience so that in case method learning, case articles will be presented to help students relate the phenomena that occur and will be discussed in discussion activities based on the results of observations and student perspectives, so that students not only memorize content but can also find out the relationship between the material taught and real world situations [8]

However, based on the results of observations conducted at SMA Negeri 1 Percut Sei Tuan, which is one of the schools implementing the Independent curriculum, 85% of teachers have heard of differentiation from the socialization of the Independent Curriculum but do not yet understand its meaning in depth. The reason that the average teacher said that they did not implement differentiated learning was because of limited understanding because it was only socialized once and was not yet in depth, besides that there was no training and assistance in its implementation either in the teaching and learning process (KBM), learning media, teaching materials and so on. On the other hand, there are several teachers (around 18%) who have implemented it in learning and on average the teachers are driving teachers. However, the teacher commented that only using a differentiated approach in the KBM process and indeed had an impact on student learning motivation because it adjusted to the learning style of each student, but on the other hand, if you look at the increase in critical and creative thinking skills, it is not enough to use a differentiated approach.

The solution offered to solve the problems experienced by teachers is to develop interactive teaching materials based on case method-differentiation. Integration of the Case Method-Differentiation learning method is relevant because it recognizes the diversity of students' levels of understanding and learning interests. The case study approach allows students to engage in real problem solving, improve their critical thinking skills, and relate physics concepts to real-world situations. Meanwhile, differentiation provides a more personalized approach and is tailored to the needs of individual students, accommodating different levels of understanding.

Awareness of the importance of innovation in the development of physics teaching materials that can increase student engagement and facilitate learning differentiation. Effective physics learning requires a more dynamic approach and is in accordance with technological developments, so there needs to be a breakthrough in creating teaching materials that can provide an interesting and relevant learning experience for students. In today's digital era, interactive digital books offer great potential to improve physics learning by presenting content in a more dynamic and interactive way. One of the digital platforms that is easy and flexible to use is the Google site website.

The selection of the Google Site platform as the basis for interactive digital books is based on the availability of easy access, online collaboration, and flexibility of content design. Google Site provides a learning environment that can be accessed online and facilitates the presentation of dynamic physics content, and allows students to interact actively. Thus, this study responds to the need for an innovative approach in the development of physics teaching materials that combine modern technology, the latest learning methodologies, and the use of diversity in student understanding. With this interactive digital book, it is expected to contribute to improving the quality of physics learning in secondary schools and motivate students to be actively involved in the learning process.

2 Method

The research was conducted at SMA Negeri 1 Percut Sei Tuan for 6 months starting from March to August 2024. The research time interval will begin with the preliminary study stage, the development study stage, the testing stage of the Interactive Digital Physics Book based on the Case Method-Differentiation via the Google Site Web and finally the writing of the research report and publication of scientific articles.

The development model that will be used in this research is the 4-D development model (four-D Model) proposed by Thiagarajan and Semmel in 1974 [9] with the implementation stages consisting of: Define, Design, Development, and Dissemination [10].

The define stage aims to determine and define the requirements needed in learning by considering and adjusting the learning needs of students. The steps in the define stage are, initial final analysis, student analysis, concept analysis, task analysis and formulation of learning objectives. The Design stage is to design a model and Interactive Digital Physics Book based on Case Method-Differentiation through the Google Site Web. Activities at this stage are selecting a digital book model, selecting a format, and initial design. The Development stage aims to produce a good final draft and has been revised based on input from experts and data obtained from field trials. This stage includes validation of teaching materials by experts followed by revisions, then implementation of trials. The Dissemination process is the final stage of a development. The Interactive Digital Physics Book based on Case Method-Differentiation through the Google Site Web that has been developed and meets the criteria for good teaching media can be given to UNIMED, especially the physics department and SMA Negeri 1 Percut Sei Tuan as a partner.

The data collection technique used in this study is an assessment instrument with a questionnaire. There will be 4 questionnaire assessment instruments, namely a material validation questionnaire, a media validation questionnaire, a question validation questionnaire, and a student response questionnaire. The questionnaire grid developed is based on the formative evaluation instrument for teaching materials published by the Ministry of National Education in 2008.

The data analysis technique used in this research and development is descriptive with a Likert scale, the descriptive analysis technique aims to describe the data that has been collected. The descriptive analysis technique is applied to assess the feasibility of the product that has been developed, namely the Interactive Digital Physics Book based on the Case Method-

Differentiation via the Google Site Web. To determine the level of validation, namely with the following steps:

1) Changing score values from qualitative data to quantitative data on a Likert scale [11].

Table 1. Media and Material Expert Scoring Rules

Score	Category
5	Very Good (SB)
4	Good (B)
3	Neutral (N)
2	Not Good (K)
1	Very Bad (SK)

2) Average equation to state the validation results of material experts and media experts:

$$Index(\%) = \sum_x \quad x\ 100\% \qquad (1)$$

With : $\sum_x$ = Maximum score

3) Changing the average score of each instrument from quantitative data to qualitative data on a five-point scale using the formula adapted from Widoyoko as in Table 2 (Widoyoko, 2013).

Tabel 2. Valid Categories

Interval	Category
80% – 100%	Very Valid
60% - 79.99%	Valid
40% – 59.99%	Neutral
20% – 39.99%	Less Valid
0% – 19.99%	Very Less Valid

3 Result and Discussion

The research was conducted at SMAN 1 Percut Sei Tuan for 6 months from March to August 2024. The results of the research and development are interactive digital books that utilize the Case Method-Differentiation principle using the Google Site web platform using the 4D research model, namely the definition stage (define), planning stage (design), development stage (develop), dissemination stage (disseminate). The results of the development research with these stages are:

3.1 *Define Stage*

The definition stage is the stage to determine and formulate learning requirements. This phase is almost the same as the analysis stage in other development models. Through an analysis, the objectives and problems of existing teaching materials or learning devices will be determined. There are four steps that are usually taken in the define stage, namely to determine and define the requirements needed in learning which include:

a. End-to-end Analysis

Based on the results of observations conducted at SMA Negeri 1 Percut Sei Tuan, which is one of the schools implementing the Independent curriculum, 85% of teachers have heard of differentiation from the socialization of the Independent Curriculum but do not yet understand its meaning in depth. The reason that the average teacher said that they did not implement differentiated learning was because of limited understanding because it was only socialized once and was not yet in depth, besides that there was no training and assistance in its implementation either in the teaching and learning process (KBM), learning media, teaching materials and so on. On the other hand, there are several teachers (around 18%) who have implemented it in learning and on average the teachers are driving teachers. However, the teacher commented that only using a differentiated approach in the KBM process and indeed had an impact on student learning motivation because it adjusted to the learning style of each student, but on the other hand, if you look at the increase in critical and creative thinking skills, it is not enough to use a differentiated approach.

b. Student Analysis

The student analysis stage is carried out to determine the attitude or character of students in the learning process. The students analyzed are class X students who have implemented the independent curriculum. The results of the observation show that on average each class stated that physics lessons are the most difficult compared to other natural science groups such as Mathematics, Chemistry and Biology. In addition, in the independent curriculum implemented by teachers only apply learning style adjustments during discussions, while the teaching materials do not adjust. So an interactive digital book was developed that utilizes the Case Method-Differentiation principle using the Google Site web platform.

c. Material Analysis

Based on the results of observations in physics, the material applied is Vibration and Waves, Temperature and Heat, Thermodynamics, Electricity and Magnetism, Physical Optics.

d. Task Analysis

Students are directed to work independently on the problems they are facing, so that students can solve problems individually assisted by the available teaching materials. Furthermore, students are expected to be able to apply the concepts they have learned to solve problems related to the material in the teaching materials.

3.2 *Design Stage*

a. Development of ideas/concepts

The design stage is carried out by the developer based on the information that has been obtained, namely determining and searching for objects that will be developed in the smart module for practical guidance in the form of images, videos and animations.

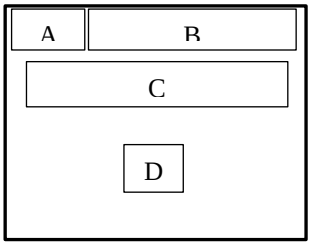
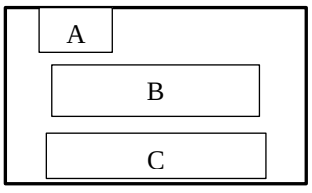
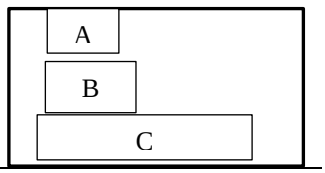
b. Concept Analysis

Concept analysis on the research title "Development of Interactive Digital Books Utilizing Case Method-Differentiation Principles Using the Google Site Web Platform" focuses on the integration of two main pedagogical approaches, namely Case Method and differentiation, in a digital book format. The Case Method concept focuses on real-case-based learning that allows students to develop analytical and problem-solving skills in relevant contexts. Meanwhile, differentiation refers to the adjustment of teaching materials and methods based on students' individual needs, interests, and abilities, which aims to maximize their learning potential. Interactive digital books developed with these principles must be able to provide content that is not only interactive, but also flexible in meeting different learning needs. The Google Site platform was chosen because of its ability to present materials dynamically and accessible, although challenges remain in terms of optimizing content to suit both concepts.

c. Creating a storyboard

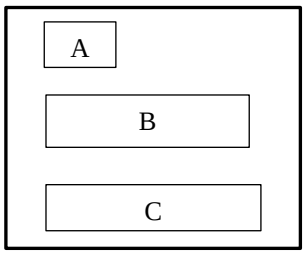
The format selection stage is carried out by the developer by describing the storyboard. The storyboard is made to make it easier to visualize the main display so that it is more organized. The creation of the storyboard is made as detailed as possible up to the planning of the development of an interactive digital book that utilizes the Case Method-Differentiation principle using the Google Site web platform. The appearance of the Storyboard can be seen in table 3.

Table 3. Interactive digital book storyboard Case Method-Differentiation

No	Component	Visualization
1	Cover Page: A — Information: Logo Page: B — Information: Menu Page: C — Information: Menu Image Page: D — Information: Copyright	
2	Visual/Reading page view Page: A — Information: Home Page: B — Information: Material Page: C — Information: Copyright	
3	Audiovisual page view Page: A — Information: Home Page: B — Information: Video Page: C — Information: Copyright	

4 Kinestetic page view

Page	Information
A	Home
B	Video
C	Copyright



3.3 *Develop Stage*

a. Creating an Interactive Digital Book Case Method-Differentiation

Stages of product development of Interactive Digital Book Case Method-Differentiation by referring to the story board that has been created and arranged previously so as to facilitate the creation of Interactive Digital Book Case Method-Differentiation. The following is the initial display of Interactive Digital Book Case Method-Differentiation with the creation of the sites.google.com application.

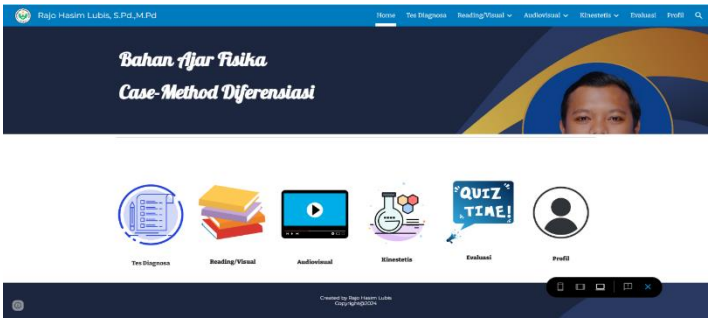


Fig. 3. Cover

b. Alpha Testing and Product Revisions

The completed development product will then go through a validation stage by experts consisting of media experts and also material or content experts.

1) Media expert validation

The Media Experts who were appointed as assessors of the digital-based teaching material development product with this digital book product were Mrs. Tuti Hardianti, S.Pd., M. Pd and Ladestam Sitinjak, S.Pd., M. Pd who are lecturers in the Physics Education Study Program with KDBK Teaching Materials in the Physics Department, Faculty of Mathematics and Natural Sciences, State University of Medan.

a) Data Presentation

The development products submitted on Wednesday and 22th July, 2024 to the teaching materials expert are interactive digital textbook products based on the case method-differentiation.

Table 4. Media Expert Validation Results

Question Items	Validator 1	Validator 2	Difference
1	3	4	1
2	4	4	0
3	5	4	1
4	3	3	0
5	4	5	1
6	5	4	1
7	3	4	1
8	4	5	1
9	4	5	1
10	4	4	0
11	5	4	1
12	4	4	0
13	5	5	0
14	4	5	1
15	4	4	0
16	5	4	1
17	5	5	0
18	4	5	1
19	5	4	1
20	5	4	1
Amount	85	86	

Based on the assessment by the learning media expert, the accuracy of language, layout, illustrations, graphics and photos received a very good assessment. Furthermore, the use of fonts and display designs received a good category, with comments and suggestions from the validator being that the use of font size and type should be improved for consistency and aesthetics, and the cover should be too monotonous and plain with suggestions to be improved by making it full color and animation related to physics material.

b) Data Analysis

The results of the assessment by media experts as listed in table 4 can then be calculated as the percentage of achievement level as follows:

$$Index\ (\%) = \sum x \times 100\%$$

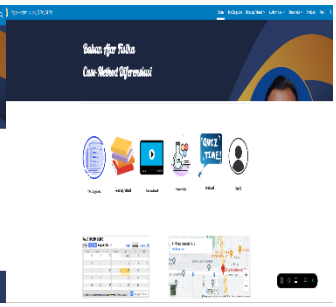
$$= 171/2\ x\ 100\% = 85{,}5\%$$

After being converted using the conversion table, the percentage of achievement level of 85.5% is in the very good qualification with a description of minor revisions, but improvements are needed so that the resulting product becomes even better.

c) Development product revision

Based on the results of comments and suggestions from media experts, the Interactive Digital Book Case Method-Differentiation does not need to be revalidated because it is in a very good qualification, but improvements need to be made according to comments and suggestions from media experts so that the development results produced are better. The following is a list of improvements to the Interactive Digital Book Case Method-Differentiation product listed in table 5.

Table 5. Interactive Digital Book Improvement List Case Method-Differentiation

Suggestion	Before Revision	Repair Results
On the home menu, create the date and address to add aesthetic value.		

2) Material expert validation

The learning material experts who were appointed as assessors of the Interactive Digital Book Case Method-Differentiation product were Mr. Budiman Nst, M.Si and Mr. Irfandi, M,Si who are Lecturers in the Physics Study Program, Physics Department, FMIPA UNIMED.

a) Data Presentation

Development products submitted on Thursday and 25th July, 2024 to the Material expert to test the Interactive Digital Book product Case Method-Differentiation.

Table 6. Material Expert Validation Results

Question Items	Validator 1	Validator 2	Difference
1	4	5	1
2	5	4	1
3	3	3	0

4	5	4	1
5	4	4	0
6	4	3	1
7	3	3	0
8	4	4	0
9	4	5	1
10	4	3	1
11	4	4	0
12	4	5	1
13	3	4	1
14	4	5	1
15	5	4	1
16	4	4	0
17	4	5	1
18	4	5	1
19	4	4	0
20	4	5	1
Amount	80	83	

Based on the results of the material test conducted by material experts, there is a good eligibility of the content of the product made, namely the conformity of the learning achievements of the course with the material and content of the Interactive Digital Book Case Method-Differentiation, the material in the Interactive Digital Book Case Method-Differentiation is also in accordance with the depth of the physics material and according to student needs. In addition, the relevance of the product made in the very good category, namely the clarity of the problem formulation and evaluation has been attached to each material. Comments and suggestions from experts are to pay more attention to effective and efficient language, namely minimizing the use of pronouns or even eliminating them, then avoiding the use of conjunctions at the beginning of sentences, another comment is the order of presentation.

b) Data Analysis Data

The results of the assessment by material experts as listed in table 6 can then be calculated as follows:

$$Index\ (\%) = \sum x \times 100\%$$

$$= 173/2\ x\ 100\% = 81{,}5\%$$

After being converted with the conversion table, the percentage of achievement level of 81.5% is in the very good qualification with the statement that it does not need to be revised. The Interactive Digital Book Case Method-Differentiation is in the very good qualification with the statement that it does not need to be revised, however, improvements are needed so that the resulting product becomes even better.

c) Development product revision

Based on the results of comments and suggestions from material experts, the Interactive Digital Book Case Method-Differentiation does not need to be revalidated because it is in a very good qualification, but improvements need to be made according to comments and suggestions from media experts so that the development results produced are better.

4 Conclusion

The temporary conclusion from the implementation of this research is that the Interactive Digital Book Case Method-Differentiation is still in the development stage and is valid in terms of media and materials because it has been validated by the respective experts, however, it has not yet reached the product trial stage so its effectiveness is not yet known.

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