# Modern Physics E-book Based Multirepresentation for Hybrid Learning

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**Abstract**

This research is a development research that aims to describe the feasibility of material, pedagogic and media aspects of e-books based multirepresentation for hybrid learning on Modern Physics material. This research model uses 4D (Define, Design, Develop, and Disseminate). The data collection technique is that the validator assigns a score to each aspect on the validation sheet and then the data is analyzed to see the percentage of validation. In this study the validators consisted of each aspect as many as two validators as material, pedagogic, and media experts. The results showed that the e-books based multirepresentation for hybrid learning on Modern Physics material was feasible to use with a percentage gain from material experts of 62% (fair enough); from pedagogic experts by 89% (very feasible); from media experts by 92% (very decent). As for the results of the aiken calculation, for the material aspect, the score is 0.50 (medium); the pedagogic aspect got a score of 0.85 (high); and the media aspect scored 0.89 (high).

**Keywords**: Ebook; multirepresentations; hybrid learning

## Introduction

Becoming a teacher is challenging in the sense that it does not only require a high level of intelligence high because of the tremendous explosion of information, but also must be capable of higher technology empowerment. Twenty-first century teachers must possess research and technology skills, in addition to of distinctive pedagogical skills (Dar & Ponraj, 2022). Technology here means a tool that can be used in the learning process (Cunanan et al., 2022).Teaching and learning activities reflect the process of delivering information from teachers to students (Carless, 2022). Professional teachers must be able to convey learning materials well so that learning outcomes can be carried out. Of course, by preparing creatively guided learning materials. One way that can be done is to develop teaching materials. Through teaching materials, the professional competence of teachers will be seen. As said by Aydin & Ayetkin (2018) that teaching materials play an important role in teacher competence. Teaching materilas are an important part in the implemetation of learning process (Dewi et al., 2021).The teaching materials developed must be packaged interactively and can improve the quality of students. However, not only that, developing teaching materials also requires consideration of the characteristics of students as the main users (Sinaga et al., 2015). This can be met by developing multi-representation teaching materials.

The facts on the ground show that physics learning in schools still uses only one or two representations, namely verbal and mathematical equations. In addition, it was also found that learning was monotonous due to the lack of use of graphics and illustrations (Katel, 2021). Simbolon & Parlindungan (2015) revealed in his research that the teaching materials used in high school include low-level topics, focused on mathematical equations, the lack of students' main priorities about science, the lack of scientific explanations related to the real world so as to provide little opportunity for students to develop explanations of an event.

To overcome this problem, the development of multi-representation-based electronic books can be carried out by teachers. The urgency of using a representation-based ebook is that it can improve the quality of students. As said by Mulhayatiah et al. (2022) that multi-representation-based teaching materials are one solution to improve the quality of students both in understanding concepts, learning outcomes and problem solving abilities. This can answer how the solution for learning is where the way students learn is different, such as students who learn through reading texts, students who learn to use visual images, and students who learn through mathematical equations (Park et al., 2022).The advantage is that students can understand learning, especially learning physics in more depth (Nakhleh & Postek, n.d.). Because Hand et al (2009) said that multi-mode representation of science concepts is related to a complete conceptual understanding of science concepts and the ability to apply scientific ideas.

The use of printed teaching materials will not be effective if there are obstacles in learning conditions, for example the Covid-19 pandemic. Considering that teachers are facilitators or mentors to support student learning (Comuyog, 2022) during the Covid-19 pandemic teachers can use ebooks (electronic books) as an alternative for delivering learning information. In hybrid learning conditions, ebooks can cover face-to-face and online learning. As it is known that hybrid learning is a learning activity that combines face-to-face learning and online learning (Park et al., 2019). Hybrid learning is also refinement of the online learning model. Hybrid learning may give increased freedom for students in learning (Bullow, 2022). With the ebook, learning resources for students will be more diverse and interesting, because ebook are as effective as printed books in improving reading acquistion outcomes (Lopez et al., 2021). This study aims to determine the feasibility of developing a multi-representation-based ebook for hybrid learning on Modern Physics material.

**Methodology**

The research method used is a 4D model (Define, Design, Develop and Disseminate) developed by Thiagarajan (Thiagarajan, 1974). This development research only reached the develop stage. The steps of this research consist of (1) Define, namely analysis of needs for developing multi-representation-based ebooks; (2) Design, namely preparing storyboards; (3) Develop, namely compiling ebooks using smart app applications, media feasibility tests, pedagogical feasibility tests and material feasibility tests.

The instruments used are material validation sheets, pedagogic validation sheets and media validation sheets. The data collection technique is the validator giving the ebook eligibility score on the validation sheet. The data analysis technique was carried out by calculating the percentage of the feasibility level of a multi-representation-based ebook using the following equation.

$$Percentage = \frac{Score\ Obtained}{Maximum\ Score} x\ 100\%$$

The ebook eligibility criteria are then viewed with reference to the eligibility criteria according to Sudijono 2005, that is.

**Table 1. E-book Eligibility Criteria**

| P Value | Criteria |
|---|---|
| 20%<P≤36% | Not Feasible |
| 36%<P≤52% | Less worthy |
| 52%<P≤68% | Decent enough |
| 68%<P≤84% | Worthy |
| 84%<P≤100% | Very Worthy |

As for looking at the coefficient of content validity based on the results of the validator's assessment of n people on an item in terms of the extent to which the item represents the construct measured using the formula proposed by Aiken (1980).

$$V = \frac{\sum s}{n(c-1)}$$
$$s = r - l_0$$

Note:
$l_0$ = low eligibility rating score (eg 1)
c = high eligibility rating score (eg 4)
r = number given by rater

The results of the V Aiken value are then seen by the value criteria according to Aiken as shown in table 2 below.

**Table 2. V Aiken value criteria**

| Aiken's V Value Range | Rating Criteria |
|---|---|
| 0,68-1,00 | High |
| 0,34-0,67 | Middle |
| 0,00-0,33 | Low |

**Results**

***Development Result***

The product resulting from this development research is a multi-representation-based physics ebook on modern physics. The resulting ebook is a web-based application that can be accessed online via a smartphone. This multi-representation-based ebook presents modern physics concepts in various representations (multi-representation) and is equipped with practice questions and student worksheets. The multiple representations presented include verbal representations, representative images, mathematical representations of graphical representations and table representations. The ebook was designed using a software application, namely Microsoft word to design the material; smart apps creator application to design ebooks into smartphone applications; wizer.me for designing questions and worksheets.

Ebooks that have been designed and developed can be accessed by installing an ebook application via a smartphone. While the practice questions and worksheets can be accessed in the ebook application which will later be directed to the wizer.me site.

***Define***

In the define stage, a needs analysis is carried out to develop a multi-representation-based ebook. This needs analysis was carried out in order to determine the urgency of a multi-

representation-based ebook. This needs analysis consists of the importance of multi-representation, and multi-representation ebook as a solution. Based on the statement Ainsworth (1999) on Mulhaya-tiah et al. (2022) that multi-representation has three functions, namely as a complement to cognitive processes, minimizing misinterpretations and strengthening a deeper understanding of a concept. As for Abdurrahman et al (2019) learning using representative can improve students' critical thinking skills. The learning by applying multiple representations can improve students' cognitive abilities (Damyanov & Nikolav, 2018). Multi-representation have a benefits for concept of physics it can be understood in its entirety if it can relate macroscopic, microscopic and symbolic aspect (Rasmawan, 2020). Representations are vital elements of a good physics instructions (Danday& Monterola, 2019).

*Design*

At the design stage, a multi-representative ebook based storyboard is made.
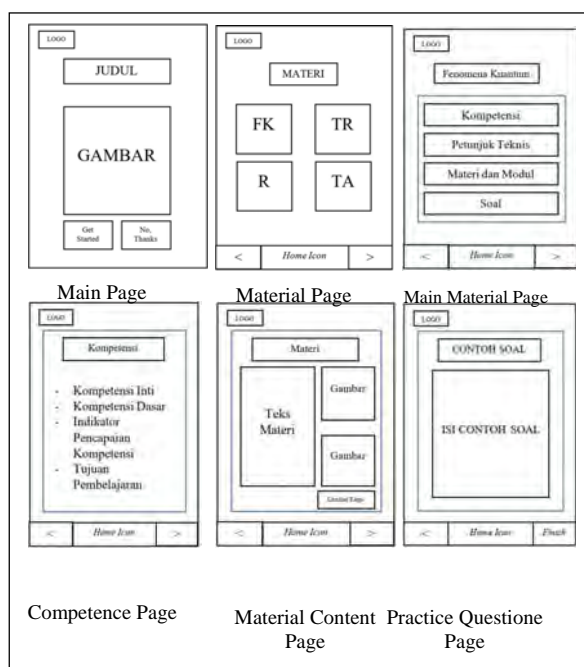


**Figure 1. Storyboard E-book Berbasis Multirepresentasi**

The storyboard consists of the main page, material page, main material page, competence page, material content page, practice questions page which can be seen in the following display. The storyboard is poured into an ebook in the form of a smartphone application using a smart apps creator application.

*Develop*

At the develop stage, namely developing ebooks, namely pouring the ebook design that is on the storyboard into the smart apps creator application. The ebook displays are as follows.

On the main page there is a cover of an ebook based on multiple representations of modern physics. In addition, there is also a logo, the title of the ebook material is "Modern Physics" and there are pictures. There are two buttons, namely "Get Started" to go to the next page and "No, Thanks" to exit the ebook application as well as the play music here button and the music icon. On the material page there is a logo, four material buttons, namely Quantum Phenomena, Relativity,

Atomic Theory, and Radioactivity. The four buttons when pressed will go to their respective material pages. And there is a Home icon button to return to the main page, the button to return to the previous page and the → button to open the next page.
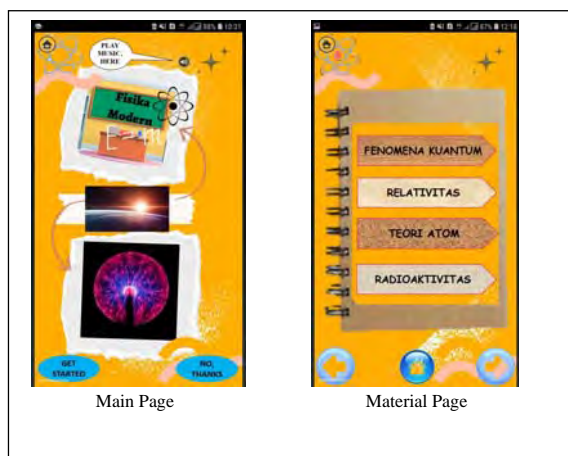


**Figure 2. Main page and material page**

On the main page of the material there is a logo, four Quantum Phenomenon buttons that read competence, technical instructions, materials and modules, as well as questions which, if pressed, will enter their respective pages. In addition, there is a Home icon button to return to the main page, the button to return to the previous page and the → button to open the next page. On the competence page there is a logo, the main section and the bottom. The main part consists of Comptetencies for learning, and Learning Objectives. at the bottom there is a Home icon button to return to the main page, the button to return to the previous page and the → button to go to the next page.
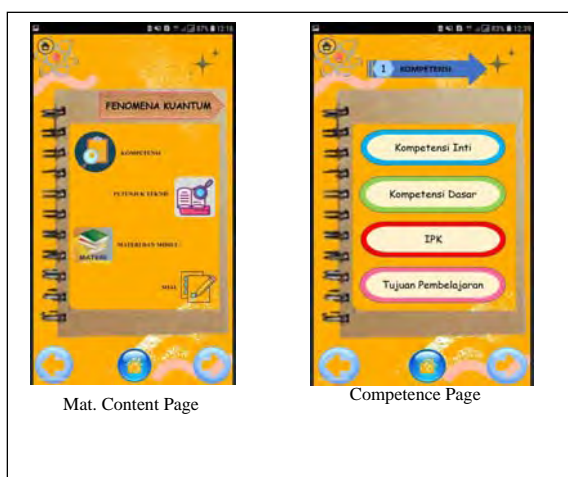


**Figure 3. Main Page Material and Pages Competence**

On the content page the main part is in the form of material text, a worksheet button.
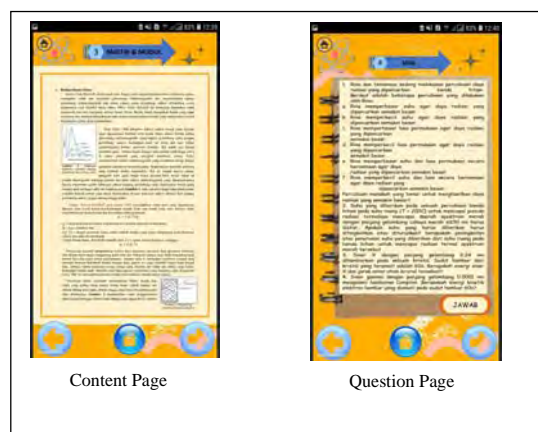
**Figure 4. Content page and question page**

*Data Analysis Results*

The ebook that has been developed in the form of a multi-representation-based modern physics ebook application is then tested for feasibility by a team of experts, namely material experts, media experts and pedagogic experts. The results of the feasibility test are described in the following description of the results of the data analysis.

*Result of Material Validation Data Analysis*

As for the material aspect, the multi-representation-based modern physics ebook was tested for feasibility by a team of two material experts. The material being tested for feasibility is modern physics material which consists of four chapters of material, namely Quantum Physics, Special Relativity, Atomic Theory and Radioactivity. The results of material validation and the coefficient of agreement of the Aiken observer are shown in the table 3.

**Table 3. Material Validation Result**

| Subject Matter | Expert 1 | Expert 2 | Total | V |
|---|---|---|---|---|
| QP | 5 | 8 | 60% | 0,46 |
| RT | 8 | 9 | 77% | 0,77 |
| AT | 8 | 12 | 66% | 0,16 |
| R | 5 | 14 | 63% | 0,63 |
| Mean | | | 67% (Decent enough) | 0,50 (Middle) |

Note: QP = Quantum Phenomenon; RT = Relativity Theory; AT = Atomic Theory; R = Radioactivity

Based on the feasibility test on the material aspect by 2 material experts, it was found that the multi-representation-based ebook was in the fairly decent category with a percentage value of 67%. These results indicate that the multi-representation-based ebook on Modern Physics material is feasible to be used as student learning material because it is in accordance with the needs of learning achievement indicators. Based on the table above, it can be seen that in qualitative descriptive analysis the V Aiken value of the material validator is 0.50 with a medium category.

*Pedagogic Validation Data Analysis Result*

In the pedagogic aspect, the ebook developed was validated by a pedagogical expert validator, consisting of 2 expert teams. In the pedagogic aspect, it consists of 16 statement items with a

score range of 1 to 4. The points include (1) Conformity of content with competence, and indicators and learning objectives to be achieved; (2) Presentation of content in a precise, accurate, relevant, contextual and innovative manner; (3) Content development is creative, interesting and free from misconceptions; (4) the suitability of the depth and breadth of content with the level of the reader; (5) Accuracy in explaining common misconceptions; (6) The content combines theoretical understanding and its application in daily life in a professional manner; (7) The correspondence between the description of the verbal (text) and visual representation mode (pictures, diagrams, tables, graphs, or mathematical equations); (8) The correspondence between the description of verbal (text) and dynamic (simulation and video) representation modes; (9) Content descriptions encourage the development of scientific reasoning and conceptual understanding; (10) Teaching materials guide teachers to identify the characteristics of students before the learning process properly (initial knowledge and knowledge that students should already know); (11) Teaching materials guide teachers in the use of an active, effective, and learner-centered learning approach; (12) The learning strategies offered are in accordance with constructivism learning and appropriate for teaching lesson content accompanied by concrete examples of its application; (13) The accuracy of the learning activities provided to develop the potential and creativity of students (literature studies and technology-based experiments); (14) The accuracy of learning tools and media used in learning activities (Video and Virtual Laboratory with PhET Simulation); (15) Facilitating teachers in developing their potential by adapting the progress of the times through various sources (books, research results, and information technology); (16) Integrating pedagogic knowledge, content, and technology appropriately in developing the learning process. The validation results are shown in the following table 4.

**Table 4. Pedagogic Validation Results**

| Statement Item | Expert 1 | Expert 2 | Total | V |
|---|---|---|---|---|
| 1 | 3 | 4 | 7 | 0,83 |
| 2 | 3 | 4 | 7 | 0,83 |
| 3 | 3 | 4 | 7 | 0,83 |
| 4 | 3 | 3 | 6 | 0,67 |
| 5 | 3 | 4 | 7 | 0,83 |
| 6 | 4 | 4 | 8 | 1,00 |
| 7 | 4 | 4 | 8 | 1,00 |
| 8 | 4 | 4 | 8 | 1,00 |
| 9 | 3 | 4 | 7 | 0,83 |
| 10 | 3 | 3 | 6 | 0,67 |
| 11 | 4 | 4 | 8 | 1,00 |
| 12 | 3 | 4 | 7 | 0,83 |
| 13 | 3 | 3 | 6 | 0,67 |
| 14 | 4 | 4 | 8 | 1,00 |
| 15 | 3 | 4 | 7 | 0,83 |
| 16 | 3 | 4 | 7 | 0,83 |
| Total | 53 | 61 | 114 | 0,85 |
| Precentage | 83 | 95% | 89% | High |

Based on the feasibility test on the pedagogic aspect by 2 pedagogical experts, it was found that the multi-representation-based ebook was in the very feasible category with a percentage value of 89%. These results indicate that the multi-representation-based ebook on Modern Physics material is appropriate to be used as student learning material because it refers to the construct of modern physics material, which contains appropriate rules, theories, and learning methodologies. Aiken's V value from the pedagogic validator is 0.85 with a high category.

*Media Validation Data Analysis Results*

In the media aspect, the developed multi-representation-based ebook was tested for feasibility by a validator consisting of 2 media experts. The media aspect consists of three criteria that are assessed, namely presentation criteria, visual communication criteria and language structure criteria. The total statement items on the media aspect are 21 statement items. The presentation criteria consist of 10 statement items, namely, (1) The ebook technology used can facilitate information literacy and information technology; (2) Ebooks have met the standard of learning media; (3) Ease of using Ebooks; (4) the suitability of the technology (images, animations, learning videos) used with the content and learning strategies; (5) Clarity of ebook general instructions/guide; (6) Use of language that is easy to understand and suitable for readers; (7) Consistency in the use of terms and symbols; (8) Attractive ebook design and layout based on the selection of type and size of letters, illustrations, colors and layouts; (9) Compatibility of display and background colors; (10) The accuracy and quality of images, animations and videos. Visual communication criteria consist of 5 statement items, namely, (11) Communicative: visual and audio elements relate to the material, so that it is easily understood by readers; (12) Creative: visualization is presented in a unique way and is often used, to attract attention; (13) Simple: visualization is not complicated, so as not to reduce the clarity of the content of the material and easy to remember; (14) Unity: using visual and audio language that is harmonious and intact, so that the teaching material is understood as a whole (comprehensive); (15) Up-to-date materials related to technology. The criteria for language structure consist of 6 statement items, namely, (16) Selection of language that is easily understood by the thinking level of students; (17) Language compatibility with PUEBI; (18) The correctness of the terms used; (19) The suitability of the stimulus to explore the curiosity of the user; (20) The content is described in a language that is easy for readers to understand; (21) The scientific terms used are already familiar to the reader. The results of media validation based on the three aspects above are shown in the table 5.

**Table 5. Media Validation Result**

| Aspect | Expert 1 | Expert 2 | Total | V |
|---|---|---|---|---|
| Presentation | 34 | 39 | 91% | 0,88 |
| Visual Communication | 17 | 19 | 90% | 0,86 |
| Structure Language | 22 | 24 | 95% | 0,94 |
| Mean | | | 92% | 0,89 |

Based on the media feasibility validation criteria, the results obtained that the multi-representation-based ebook on the presentation criteria obtained a percentage of 91% with a very decent category; on the visual communication criteria obtained a percentage of 90% with a very decent category; and on the criteria of language structure obtained a percentage of 95% with a very decent category. Overall, based on all the criteria, multi-representation-based ebooks on modern physics material show an average value of 92%, which means that it is very suitable to be used as a

learning medium for students. The V Aiken value from the media validator is for the presentation criteria of 0.88 in the high category; on the visual communication criteria of 0.86 with a high category; and in the category of language structure of 0.94 with a high category. Overall, the V Aiken value of the media validator on each criterion shows an average construct validity coefficient of 0.89 which is included in the high category.

Overall, the results of the feasibility test for multi-representation-based ebooks, both in terms of material, pedagogic and media aspects, show that the developed ebook is feasible to use. This means that a properly designed ebook can be used in learning. This ebook can operated on students mobile phones to improve critical thinking skills students. As research conducted by (Sinaga & Mey, 2022) that electronic teaching materials can operated on student mobile phones and the critical thinking skills of students can be increasing. This is a solution to answer the use of teaching materials in schools which only consist of one representation. Thus this ebook can be used to improve the quality of students. The same thing was also expressed by Bicer (2021) in his research that multiple representation can be used by students in the learning process to develop their creative thinking. The existence of a multi-representation also answers how to change students understanding into knowledge of correct concept (Pikoli, 2020).

Based on research results by Becker et al., (2020) in their research teaching materials in the form of mobile phones have shown positive effect on conceptual understanding. The existence of multi-representation-based ebooks also answers how the use of ebooks in learning can train reading, listening, writing and speaking competencies. Another positive result was stated by Derman & Jazlin (2020) that the use multiple representations in learning can increase cognitive structure. Another positive thing expressed by Hongming et al., (2021) that representations of scientific concepts are important.

### Discussion

The results of the study show that the use of e-books as teaching materials used in the learning process during the Covid-19 pandemic is something that can be said to be effective. An ebook product based on multiple representations of Modern Physics material in the form of a smartphone application that has been made suitable for use. This may be because the use of this e-book has many advantages, one of which is that students can study independently so that they can repeat the material by rereading the e-book. The reason for the existence of e-books in learning is because teachers need media or teaching materials as a means of delivering material, especially in physics subjects which are often found in abstract material and cause many misconceptions. Therefore, teachers are required to be able to choose media that are truly effective and efficient in explaining the material (Suparsa & Mantra, 2020). Because a teacher plays a significant role in attaining an improved quality of teaching learning process, and in building a nation (Rural, 2021). For this reason, teachers must improve their competence so that education can be of high quality (Villegas, 2022).

### Conclusion

This development research produces a multi-representation-based ebook product on Modern Physics material in the form of a smartphone application. Based on the results of the material feasibility test, multi-representation-based ebooks fall into the category of quite suitable for use with a percentage gain of 62%; on the results of the pedagogic feasibility test, multi-representation-based ebooks fall into the very suitable category for use with a percentage of 89%; while on the results of the media feasibility test, multi-representation-based ebooks fall into the very feasible category with

a percentage gain of 92%. Overall, it can be concluded that the multi-representation-based ebook is appropriate to be used as physics teaching material on the topic of Modern Physics.

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