



INTERACTIVE E-BOOK FOR PHYSICS LEARNING: ANALYSIS OF STUDENTS' CHARACTERS AND CONCEPTUAL UNDERSTANDING

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ABSTRACT

The national education curriculum is concerned with character building. The development of media with character needs to be done to strengthen character and to help students understand the momentum and impulses concept. This study aims to (1) develop an interactive e-book and (2) describe the character and understanding of students' concepts after using the e-book. The development model used Lee & Owens with the stages: analysis, design, development and implementation, and evaluation. An interactive e-book was prepared by combining character values in the content, discussion sheets, and online evaluation. The e-book product contains images, videos, text input functionality and can be accessed via a smartphone. Students can study matter, momentum, and impulses without the basis of space and time. The results of the study state: (1) interactive e-books are feasible and easy to use by students (2) e-books that provide character reinforcement and are effective in increasing understanding of concepts in 10% low categories to 60% high categories

E-BOOK INTERAKTIF DALAM PEMBELAJARAN FISIKA: ANALISIS KARAKTER DAN PEMAHAMAN KONSEP SISWA

Kata Kunci:

Pemahaman Konsep
E-book interaktif
Karakter Siswa

ABSTRAK

Kurikulum pendidikan nasional berkaitan dengan pembentukan karakter. Pengembangan media bermuatan karakter perlu dilakukan untuk penguatan karakter dan membantu siswa memahami konsep momentum dan impuls. Penelitian ini bertujuan untuk (1) menghasilkan *e-book* interaktif dan (2) mendeskripsikan karakter dan pemahaman konsep siswa setelah menggunakan *e-book*. Model pengembangan menggunakan Lee & Owens dengan tahapan: *analysis, design, development and implementation*, serta *evaluation*. E-book interaktif disusun dengan memadukan nilai karakter pada isi materi, lembar diskusi, dan evaluasi *online*. Produk e-book berisi gambar, video, fasilitas input teks serta dapat diakses melalui smartphone. Siswa dapat mempelajari materi momentum dan impuls tanpa dibatasi ruang dan waktu. Hasil penelitian menyatakan (1) e-book interaktif layak dan mudah digunakan oleh siswa (2) e-book berpotensi memberi penguatan karakter dan efektif meningkatkan pemahaman konsep siswa dengan skor 10% berkategori rendah menjadi 60% berkategori tinggi

1. INTRODUCTION

One of the digital innovations in learning resources is that printed teaching materials have begun to be developed into digital teaching materials, such as electronic books. E-books have greater flexibility and accessibility compared to printed books [1],[2]. The government through the Ministry of Education and Culture has made e-books in the form of electronic school books. However, these electronic school books do not have much character value and tend to be like printed books, without the necessary simulations and interactive media. E-books should be able to contain content that displays interactive simulations by combining text, images, audio, video, and animation so that learning becomes more interesting and fun [3].

The development of technology and information also has a negative impact on education, such as making it easier for students to access information outside the context of learning during learning, facilitating plagiarism while doing assignments, and making students less communicative because they focus on games or social media. According to Chusna, The use of gadgets, which is a technology product, can also affect the character development of students, for example, students become unable to communicate optimally with their surroundings [4].

To overcome this, efforts to strengthen character in students are needed. One of the government's efforts to strengthen student character is through the national education curriculum related to character. Embedding character in learning can be done by utilizing learning media [5]. The use of media in learning tends to be limited to facilities to make it easier for teachers to deliver subject matter [5]. Therefore, it is necessary to develop media such as e-books that can teach cognitive skills and character that are designed according to needs. Through character-based learning, such as being accustomed to being honest, disciplined and independent, curious and communicative in doing assignments, it is hoped that it can produce good character and affect activities outside the classroom. [6].

Based on the results of the analysis conducted at SMA N 3 Jambi city, it was found that physics learning uses a national curriculum related to character, but the use of media in learning is still not optimal. Students also think that Physics is a difficult subject and the concepts are interrelated, so that if you do not master one concept, it will be difficult to learn other concepts. This statement is in line with opinion [7][8]. Learning Physics contains facts, concepts, laws and theories to solve problems in everyday life [9][10]. One of the difficult physics topics to understand is the momentum and impulses. This difficulty can result in a lack of understanding of students' concepts and errors in understanding concepts. Students' errors in interpreting the theory or understanding of students' concepts that are not in accordance with the theory of experts are called misconceptions [11].

The results of previous research on understanding concepts in momentum and impulse inform that the average percentage of misconceptions on momentum and impulse in SMA Muhammadiyah and SMAN 1 Arjasa is 14% with the low category [12]. Furthermore, the results of identification of 34 students by Anggarini found that there were 29 students who experienced misconceptions with the highest percentage of misconceptions 42.86% on the sub-topic of energy conservation, and momentum [13]. One of the appropriate learning models to reduce misconceptions is problem-based learning, this is in line with the research results of O. Akinoglu and R. Ö. Tandoğan which stated that problem-based learning affects conceptual development and reduces student misconceptions [14]. Interactive media such as e-book has also proven effective in reducing students' misconceptions on the subject of dynamic electricity [15] and e-books are also effective in enhancing the learning experience of students [16]. In addition, other

studies also show that students who use media in learning experience better conceptual improvements than students without media assistance [17]

Various techniques for measuring students' conceptual understanding and misconceptions have been widely used, one of which is a four-tiered diagnostic test [18]–[20]. When compared with previous studies that only used multiple choice questions [12] and three-tier test [13], The four tier format diagnostic test provides more detail in determining the criteria for understanding concepts and misconceptions. The four tier test can reveal answers, confidence in the answers, reasons, and the level of confidence of students regarding the reasons given [21]. Four-tier diagnostics can also show parts of the material that require deeper learning with different methods for students [18].

Based on these problems, this study focused on (1) developing interactive e-book and (2) describing students' character and conceptual understanding after using interactive e-book on momentum and impulse. In previous research [22]–[24] Regarding physics e-books, most e-books can only be accessed via computer, do not contain characters, and do not reach to analyze students' understanding as a result of using e-books. The e-book developed in this research combined character values in the content, discussion sheets, and evaluation and can be run using a computer or smartphone. Through interactive e-book, students can learn impulses and momentum without being limited by space and time. The character content in this e-book was limited to honest, disciplined, independent, curious, and communicative characters. The e-book product also contains image, video and text input facilities and is operated using the Foxit PDF Reader.

2. METHOD

The development model used is Lee and Owens' model [25] with the following stages: 1) assessment and analysis, (2) design, (3) development and implementation, and (4) evaluation. The research procedure can be seen in Figure 1.

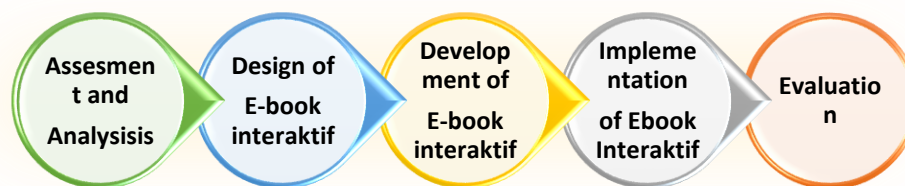


Figure 1. Development Procedure [25]

Respondents of this study were students of class XI MIA SMA Negeri 3 Jambi. The individual trial involved 3 students with various ability characteristics, namely high, medium, and low abilities. The small group trial involved 9 students with various ability characteristics. Diagnostic misconceptions involved 49 people. The diagnostic stage of misconceptions uses the One Group Pretest-Posttest Design [26] with comparing the results of test before and after using the e-book.

The instruments used in the study were (1) open questionnaire for expert validation, (2) interview guidelines for practitioner validation, (3) interview sheets and observation sheets for student responses, and (4) misconception diagnostic tests to determine the effectiveness of the e-book in improving student understanding. Open questionnaires are used to provide an opportunity to the respondents to express their opinions and analyzes [27], and interview guides can obtain more accurate data [28].

The instrument of expert validation, practitioner validation, and student responses used the content or concept validity test. The misconception instrument was made by adapting research that developed a four-tiered diagnostic test to identify misconceptions in momentum and impulse material. [29]. A four-tier diagnostic test instrument consisting of multiple-choice questions with four levels. The first level is multiple choice questions and answers, the second level is the level of confidence regarding the choice of answers, the third level is the reason for the answers given, and the fourth is the level of confidence of the reasons [21][30]. Table 1 is the category of misconceptions based on the percentage [31].

Table 1. Category Percentage Level of Misconception

Percentage	Category
0%-30%	Low
>30%-60%	Moderate
>60%-100%	High

This study uses two types of data, namely qualitative and quantitative. Expert validation, practitioner validation, and student responses were analyzed qualitatively. Student characters are also analyzed qualitatively based on the results of observations by researchers on student responses, limited to the potential of e-book to strengthen character. The effectiveness of the e-book in improving student understanding was analyzed quantitatively.

3. RESULTS AND DISCUSSION

3.1 Analysis

The analysis stage consists of a needs analysis and a final analysis. The analysis was carried out by interviewing the physics subject teacher and giving a questionnaire to 30 students of class XI who represented the entire class XI. The needs analysis informed that physics learning used a national curriculum related to character, the use of media was not optimal in learning, and the difficulty of understanding physics concepts, one of which was momentum and impulse..

The final analysis informed that students are interested in using multimedia learning. Teachers also expected teaching materials to be packaged in an attractive, interactive, contextual, and easily accessible way through student gadgets. The character also needs to be integrated into teaching materials in order to provide character reinforcement to students. Characters such as honest, disciplined, independent, curious, and communicative need to be reinforced. This is evidenced by the presence of students who cheat, are not on time in collecting assignments, have low curiosity, and lack communication between students due to the use of gadgets..

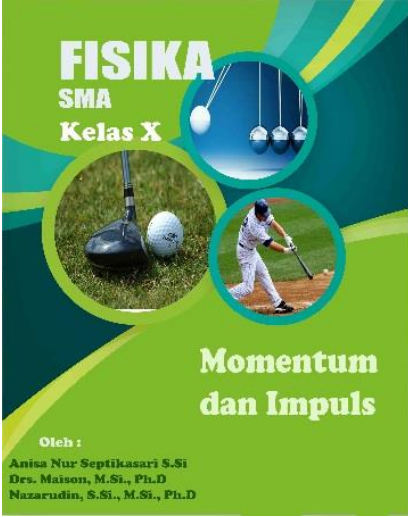
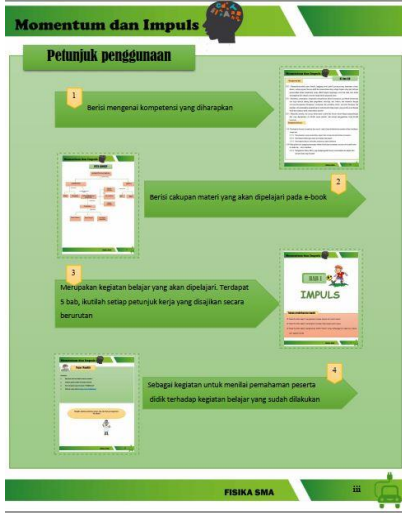
3.2 Design

The design stage produced a prototype of the Physics interactive e-book that is ready for use by users but still requires improvement in various aspects. This stage included the process of determining the required resources, material coverage, and creating a story board. The e-book developed is interactive, contains text, images, videos that can be accessed offline, exercises that can be accessed online and can provide quick feedback. E-books can be accessed using the PDF Foxit Reader. This program was chosen because it is easy to operate, easy to follow and run images, videos, audio, website links, and text.

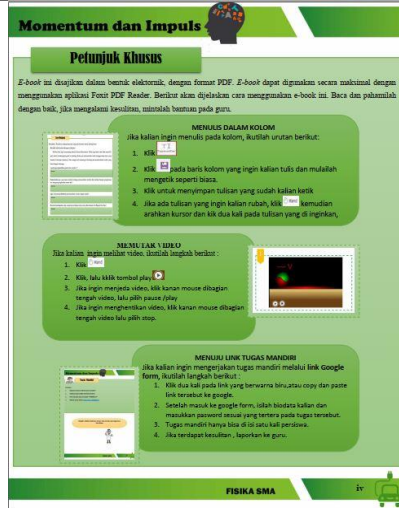
The e-book developed consists of an introduction, content, and closing. The introductory section consists of the front cover page, introduction, table of contents,

instructions for use, concept map, and a brief description of the contents of the E-book. The content section consists of lessons divided into 5 chapters, containing material, pictures, videos, and learning evaluations. The closing section contains bibliography and author profile information. The integration of characters is arranged by including character values in the content of the material, discussion and experiment sheets, evaluation, and character strengthening motivational sentences. Table 2 is an explanation of the contents of the e-book storyboard.

Table 2. Storyboard

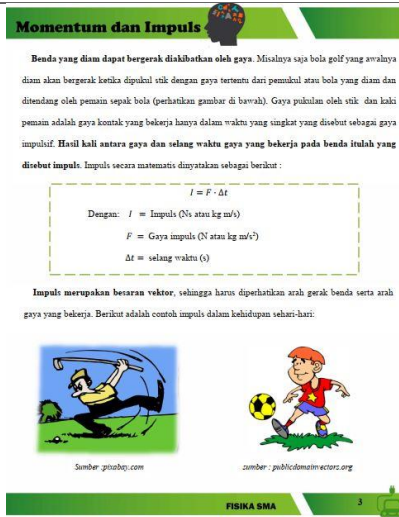
No	Visualization	Information
1		<p>This picture is a display of the e-book cover.</p>
2		<p>The picture on the side is a display of the manual for using the e-book</p> <ol style="list-style-type: none"> a. The first picture shows the competency information b. The second image contains KI and KD c. The third picture describes the material to be studied a. d. The fourth picture contains the practice questions

3



The picture on the side is a special e-book guide display
 a. The initial text contains information about this e-book format and how to operate this e-book using the Foxit PDF reader
 b. The first image is a step for text input
 c. The second image contains the steps for playing the video
 d. The third image is an image of one of the question links that can be accessed online via the Google Form

4



The picture on the side is a description of the topic in the e-book


5



The picture on the right is a contextual example of the application of momentum and impulse in everyday life. At the same time, it can provide a curious character reinforcement to students.

6

Momentum dan Impuls



Ayo Berdiskusi

Perhatikan gambar di atas! Bacalah pertanyaan berikut dengan seksama, lalu jawablah pada kolom yang telah disediakan!

- Jika kedua kendaraan tersebut bergerak dengan kecepatan sama dan menabrak pohon, manakah yang mengalami kerusakan terbesar? Kendaraan yang bermassa besar atau kecil?
Jawab:
- Jika kedua kendaraan bermassa sama (misalnya truck dengan truck) dan menabrak pohon, manakah yang mengalami kerusakan terbesar? kendaraan dengan kecepatan tinggi atau rendah?
Jawab:
- Buatlah kesimpulan, dan sampaikan kedepan kelas untuk dievaluasi oleh Bapak/Ibu Guru!
Jawab:

FISIKA SMA 13

The picture on the side is a display of the student discussion sheet. This discussion sheet can input text directly and the results of student work can be saved using the PDF Foxit Reader. It can also provide communicative reinforcement to students

7

Momentum dan Impuls

Tugas Mandiri 2

Kerjakan soal-soal berikut secara mandiri!

- Sebuah bola bermassa 2 kg dipukul dari ketinggian 5 m di atas lantai. Setelah mengenai lantai, bola tersebut dipantulkan dengan ketinggian 3,6 m. Tentukan: (a) momentum bola sesaat sebelum tumbukan, (b) momentum bola sesaat setelah tumbukan.
- Sebuah benda bermassa 200 gram bergerak lurus dengan kecepatan awal 10 m/s. Benda tersebut mengalami percepatan sebesar 2 m/s². Tentukan momentum benda saat 5 sekon.
- Perikalah manakah yang memiliki momentum lebih tinggi dari dua objek yang bergerak berikut! Jelaskan!
 - Sebuah motor dengan massa total pengendara dan motor 150 kg yang bergerak dengan kecepatan 36 km/jam
 - Sebuah peluru dengan massa 200 g dengan kecepatan 120 m/s

Ayo Berlatih 2

Petunjuk :

- Kerjakan soal-soal berikut secara mandiri!
- Pastikan peserta didik terkoneksi internet
- Password pada tugas ini adalah "TMMomentum"
- Pilihlah tautan berikut <https://bit.ly/TMMomentum>

Kejujuran adalah bab pertama dalam buku kebijaksanaan -Thomas Jefferson-

FISIKA SMA 15


The picture on the side is a display of student evaluations consisting of "Independent Assignments" and "Let's Practice". Evaluations about "Let's Practice" can be accessed online and connected to Google Form and students can immediately find out the scores obtained. At this stage there is strengthening of honest and independent character.

8

Tahukah kamu ?

SRS atau air bag dipasang pada mobil dan dirancang untuk keluar dan mengembang secara otomatis saat tabrakan terjadi. Airbag ini mampu meminimalkan efek gaya terhadap benda yang bertumbukan. Prinsip kerjanya adalah memperpanjang waktu yang dibutuhkan untuk menghentikan momentum pengemudi.

Saat tabrakan terjadi, pengemudi cenderung untuk tetap bergerak sesuai dengan kecepatan gerak mobil. Gerakan ini akan membuatnya menabrak kaca depan mobil. Peristiwa ini memerlukan gaya sangat besar untuk menghentikan momentum pengemudi dalam waktu sangat singkat. Apabila pengemudi menembuk kantong udara, waktu yang digunakan untuk menghentikan momentum pengemudi akan lebih lama sehingga gaya yang ditimbulkan pada pengemudi akan mengecil. Dengan demikian, keselamatan si pengemudi akan lebih terjamin.




FISIKA SMA 14

The picture to the side is an explanation display of a contextual example of momentum and impulse accompanied by a video that can be run without internet access or offline.

9

Kejujuran adalah bab pertama dalam buku kebijaksanaan -Thomas Jefferson-



The picture on the side is an example of a sentence that reinforces character

3.3 Development and Implementation

At the development stage of the e-book prototype, conceptual and practical improvements were made through the validation of learning design experts, material experts, media experts, and practitioners. Expert validation was carried out by lecturers at

Jambi University, while practitioner validation was carried out by teacher as learning implementer.

The learning design validation process was carried out twice by providing responses to the e-book. The product is in accordance with the aspects of learning design, including analysis of needs, characteristics and learning environment, learning objectives, assessment instruments, and evaluation. Suggestions and comments from the validator on the first validation are related to learning scenarios, and attitude assessment instruments that must be in accordance with the objectives of the e-book. In the learning scenario, the validator suggested completing the lesson plan according to the e-book, so that the expected learning process and learning time are clear. The validator also suggested making attitude assessment indicators to be achieved in the e-book. The attitude assessment made according to the aims of the e-book is honest, disciplined, independent, curious, and communicative.

Validation of material experts was carried out twice. The validator provides detailed suggestions for improvements to the e-book content, such as providing information on the class of students who will use this e-book in the cover section, deepening the material regarding the direction of impulses and momentum, increasing examples and exercises that lead to students' ability to understand the concept of momentum and impulse. In addition, the validator also suggested increasing the variety of questions from C1-C6 in order to improve the development of students' cognitive abilities at a higher level. In the concept application section, the validator provides suggestions for adding the benefits of impulse and momentum to vehicle safety such as airbags in car.

Validation of product design experts was carried out twice. The product design expert validator responded well to this interactive e-book. The colors in the e-book are quite interesting, the e-book contains images, text, videos that are proportional and in accordance with the material content. Pictures and videos have been accompanied by a narrative that fits the topic. In addition there is the highlighting of important information in the presentation of lessons. The e-book is also accompanied by a guide so that students get information to use the e-book optimally. Interactive principles are also presented in the e-book, such as providing feedback quickly in integrating audio, video, and evaluation through google form. The suggestions that have been given by the validator do not change the content and appearance of the e-book as a whole. The validator provides input to include the name of the developer/author in the e-book.

Practitioner validation was carried out once with a positive response. Validator said that e-books can be used well in learning activities. According to the validator, this e-book is easy to use, interesting, complete with evaluation, and highly supports the online learning process. E-book can also facilitate to instill student character if used in learning activities. In addition, the validator also provides input on the Basic Competencies section of the e-book, because there are errors in the use of operational verbs in basic competencies that contain psychomotor abilities. Based on validation by the practitioner, after the e-book has been corrected, the e-book is feasible to be tested

The effectiveness of the e-book was measured based on the increase in students' understanding of concepts and decreased misconceptions of students through a four-tiered diagnostic test. The diagnostic results of pre-test and post-test misconceptions are shown in Table 3 below.

Table 3. The Average Score on the Correct Answers in the Pre-test and Post-test

Question Number	1		2		3		4		Mean	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Tier 1 only	14%	88%	45%	61%	8%	78%	53%	61%	30%	76%
Tier 1 and 3 only	14%	78%	16%	35%	0%	76%	33%	47%	16%	63%
All Tier	8%	71%	10%	35%	0%	73%	22%	41%	10%	60%

The pre-test results in Table 3 show that most students answered correctly in tier one, namely 30%, 16% for tier one and three, and 10% for all tiers. Based on the results of the percentage of correct scores for all the tiers, it is known that the number of students who understand the concepts in the impulse and momentum material is classified into the low category because the percentage of understanding the concept obtained is <30% [21][31].

Based on Table 3, it can be seen that the results of the post-test, on average, students answered correctly for tier one, which was 76%, tier one and three were 63%, and the percentage for all tier was 60%. Based on the results of the percentage of correct scores for all tiers or those concluded as students who understand the concept, they are classified into the moderate category, because the percentage of understanding the concept obtained reaches 60% [21][31]. So that there is an increase in understanding of the concept before and after using the e-book. The results of this study are in line with the findings of previous studies which reveal that interactive e-books can improve student learning experiences [1][15][16].

Based on Table 3, it can be seen that the highest correct score is the correct score in tier one, then the correct score for tier one and three, finally the correct score for all tier. The average correct score in tier one at pre-test is 30% and post-test is 76%. The percentage of the tier one score is always higher because the instrument is in the form of ordinary multiple choice questions, so the reasons and beliefs of students choosing answers are not seen if the students answer correctly [21]. If the students answered correctly on tier one it is not said that they fully understand the concept, because there is a possibility that the student is only guessing.

The correct score in tier one and three at the pre-test was 16% and when the post-test increased to 63%, this score was lower than the score of the first tier. This is because the correct score is based on the student's choice and reason, if the answer and reason are correct then the score is 1. Then if the answer is correct and the reason is wrong, or vice versa, the score obtained is 0.

The result for correct scores on all tier in the pre-test, the percentage is 10% and on the post-test 60%, these scores are lower than the scores for tier one and three. This is because the correct score for all tier is seen based on the answers, reasons, and the level of confidence of students in choosing answers and reasons. If the student chose the correct answer and reason, as well as the level of confidence in choosing the answer and the reason is sure, then the score is 1. However, if from the four tiers the student is wrong or unsure then the score is 0.

Based on Table 4, it can be seen that the largest percentage of misconceptions occurs in the concept of conservation of energy in collisions, the results of this study are the same as the findings in Anggraeni's research [13]. There is a change in the percentage of misconceptions in the pre-test and post-test. This is in line with previous research which stated that interactive e-book and problem-based learning model can remediate student misconceptions [15][14]. However, in the matter of the kinetic energy of objects after the collision, there was no change in the percentage of misconceptions, which was still 5%. So that other learning methods or strategies are needed to remediate students' misconceptions on this concept [18].

Table 4. Percentage of Misconceptions in Pre-test and Post-test

Concept	Misconception	Percentage	
		Pre-test	Post-Test
The conservation law of momentum	The path length determines the object's final velocity	0%	0%
	Time determines the object's final velocity	0%	0%
	The path length and time determine the object's final velocity	0%	0%
Perfect elastic collision	Objects keep moving even though the energy is gone	1%	0%
	The direction of motion of the object does not change in a perfect elastic collision	4%	0%
Momentum	The magnitude of the momentum of an object is only determined by the mass of the object	0%	0%
Energy conservation on collision	The kinetic energy of the object after the collision becomes zero if the mass of the colliding object is equal	6%	4%
	The kinetic energy of the object after the collision becomes zero if the velocity of the colliding object is equal	5%	5%

3.4 Evaluation

The evaluation stage is carried out to determine the response to the resulting product [25]. The response to individual trial results reveals that the e-book is easy to use on smartphones and has clear instructions for use. Students are attracted by the appearance of the e-book which is compatible with colors, there are videos, clear sample questions, and there are online exercises that are connected to the google form. Students also provide suggestions for developers to make e-book barcodes to make it easier to access interactive e-books.

Based on small-group trials, students expressed interest and stated that they understood the explanations contained in the e-book. Based on the results of observations when the respondent used the e-book, it was seen that the students had curiosity in understanding the topic of momentum and impulse, even though the students had studied this topic in the previous semester. Students appear independent when answering online exercises available in the e-book. In addition, students are very disciplined in following directions and instructions given during product trials. Communication also occurs between students when discussing the problem of physics concepts contained in the e-book.

Based on student responses to individual and small group trials, this e-book has the advantage of containing images, videos, online exercises, text input facilities, and can be accessed via smartphones and has the potential to provide character strengthening to students. This can help students learn to improve students' understanding of the topic of momentum and impulse without being limited by time and space.

4. CONCLUSION

Based on the research and development results of the impact of an interactive e-book on high school physics learning, it can be concluded that the development of interactive e-books has been recognized as feasible and easy to use by students and has the potential to provide character strengthening. This is based on the results of expert validation, practitioner validation, student responses. This research does not reach the character improvement test, but only observes the potential for character strengthening when students use the e-book. There was an increase in concept understanding from 10% in the low category to 60% with the moderate category.

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