DOI: 10.14421/impulse.2023.31-06

IMPULSE: Journal of Research and Innovation in Physics Education
Volume 3, Issue 1, 53 – 63

© ISSN (p): 2798–1762; ISSN (e): 2798-1754
http://ejournal.uin-suka.ac.id/tarbiyah/impulse

The Educational Game Development of Physics Monopoly (Mofis) on the Materials of Momentum and Impulse for Learners at SHS/ISHS

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ABSTRACT

The use of learning media is one of the learning tools that can help in the learning process. One of them is the development of a physics monopoly educational game (Mofis) based on the needs of students. This study aims to 1) produce a Mofis on momentum and impulse material for SHS/ISHS students, 2) know the quality of Mofis for SHS/ISHS students, and 3) Knowing students' responses to the Mofis which was developed on momentum and impulse material.

This research is a Research and Development using 4D Thiagarajan models. This research was carried out up to the Develop step, namely extensive testing and implementation of Mofis. The instruments used were instrument and product validation sheets, Mofis quality assessment sheets, student response sheets, and implementation observation sheets. The product validation assessment in research uses Aiken's V scale with 3 scales. While assessing the quality of Mofis and student response sheets using a Likert scale with 4 scales.

The result of this research is a Mofis on momentum and impulse material for SHS/ISHS students. Mofis quality based on the assessment of material experts, media experts, and high school physics teachers obtained Very Good criteria with an average score for each assessment of 3.68; 3.53; and 3.83. Student responses to Mofis in the limited testing obtained the Agree criteria with a mean score of 3.24 and in the extensive testing obtained the Strongly Agree criteria with a mean score of 3.28. The results of Mofis implementation in extensive trials by observers obtained Very Good criteria with a mean score of 3.63.

INTISARI

Pemanfaatan media pembelajaran merupakan salah satu sarana pembelajaran yang dapat membantu dalam proses pembelajaran. Salah satunya ad|al|ah pengemb|ang|an educ|ation|al g|ame monopoli fisik|a y|ang did|as|ark|an kebutuh|an untuk pesert|a didik. Penelitian ini bertujuan untuk 1) Menghasilkan educational game Monopoli Fisika (Mofis) pada materi momentum dan impuls untuk peserta didik SMA/MA, 2) Mengetahui kualitas Mofis pada materi momentum dan impuls untuk peserta didik SMA/MA, dan 3) Mengetahui respon peserta didik terhadap Mofis yang dikembangkan pada materi momentum dan impuls.

ARTICLE HISTORY
Received: March 19, 2024
Accepted: April 17, 2024

KEYWORDS:
Educational Game, Momentum and Impulse, Physics Monopoly, Research and Development

KATA KUNCI:
Game Edukasi, Momentum dan Impuls, Monopoli Fisika, Penelitian Pengembangan

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Penelitian ini merupakan penelitian Research and Development (R&D) dengan model pengembangan 4D Thi|ag|ar|aj|an y|ang terdiri d|ari t|ah|ap Define, Design, Develop, dan Dessiminate. Peneliti|an ini dil|akuk|an s|amp|ai p|ad|a t|ah|ap Develop y|aitu uji cob|a lu|as d|an keterl|aks|an|a|an Mofis. Instrumen y|ang digun|ak|an berup|a lemb|ar v|alid|asi instrumen d|an produk, lemb|ar penil|ai|an ku|alit|as Mofis, lemb|ar respon pesert|a didik, d|an lemb|ar observ|asi keterl|aks|an|a|an. Penil|ai|an v|alid|asi produk d|al|am peneliti|an menggun|ak|an sk|al|a |Aiken's V deng|an 3 sk|al|a. Sed|angk|an penil|ai|an ku|alit|as Mofis d|an lemb|ar respon pesert|a didik menggun|ak|an sk|al|a Likert deng|an 4 sk|al|a.

Hasil dari penelitian ini adalah educational game monopoli fisik|a (Mofis) p|ad|a m|ateri momentum d|an impuls untuk pesert|a didik SM|A/M|A deng|an kriteri|a s|ang|at b|aik (SB) berd|as|ark|an penil|ai|an |ahli m|ateri, ahli media, dan guru fisika SMA dengan rerata skor untuk tiap penilaian sebesar 3,68; 3,53; dan 3,83. Respon pesert|a didik terh|ad|ap Mofis p|ad|a uji cob|a terbatas memperoleh kriteria Setuju (S) dengan rerata skor 3,24 dan pada uji coba luas memperoleh kriteria Sangat Setuju (SS) dengan rerata skor 3,28. Hasil dari keterlaksanaan Mofis p|ad|a uji cob|a lu|as oleh observer memperoleh kriteri|a Sangat Baik (SB) dengan rerata skor 3,63.

A. Introduction

Relevant educational advancement with the educational changes undergoes innovation both theoretically and practically to realize excellent educational quality [1]. Education is strongly correlated to science, personal development, and personal character. Thus, education could help individuals with cognitive, affective, and behavioral achievements [2]. The learning process determines the educational quality because the learning process could realize reliable and independent individuals after joining the learning process (Prameswari et al., 2018). Learning refers to the promoted efforts by teachers to realize the targeted learning by directing the learners in learning activities. Therefore, learners must participate in the correct learning process with responsible teachers to create a learning process based on the learners' characters [3].

Classroom learning is inseparable from various influential components. Some crucial components of the learning process are teachers, learners, the relationships among teachers and learners, the applied teaching methods, and the applied learning media to influence the learners' learning outcomes [4] [5]. Learning process especially for physics learning requires conceptual understanding, scientific attitude, and implementation of equation to solve problems [6]. However, many lessons and learning are oriented on theoretical mastery and memorization. The lesson also does not apply various learning media so the learners cannot develop their skills maximally [7]. The teachers must prepare the physics learning attractively to realize joyful and meaningful learning for the learners. On the other hand, learners must fully realize and actively and enthusiastically participate in the learning to master the materials and gain positive impacts on the learning outcomes.

The applicable learning media could mediate the material delivery of the teachers [8]. Therefore, teachers must master various learning models and methods and use various relevant learning media based on the material characteristics to attract the attention and interest of the learners. These efforts are important to improve the learners' learning achievements [9]. Learning media refers to learning components with important roles in teaching-learning activity. Learning media for education is important in the teaching-learning process to facilitate information sharing and knowledge transfer for the learners. Learning media could be a solution to teacher-learning communication problems so that the teaching-learning process could be directed. Learning media is important to keep the focus of learners' senses during material sharing [10].

The implementation of the lecturing method in physics learning at schools is less effective for the learners. This method only allows one-way communication from the teacher to the learners. Thus, the learners become passive. The implementation of the lecturing method for the learners requires them to memorize the information without conceptual understanding. These matters make the learners bored and passive in learning [6]. Physics learning becomes joyful learning for the learners based on the efforts of the teachers to realize the classroom learning atmosphere. A joyful learning

activity should involve the learners to actively participate in the learning. The actively involved learners could improve their material understanding based on the given materials [6].

A lively and meaningful learning atmosphere realization may apply an educational game media [11]. Educational game refers to a game theme with educational value to amuse during the learning process and mediate the learning material [12]. An educational game for physics learning is useful as an alternative learning media and source to train the learners actively in learning.

The implementation of the educational game has positive impacts, such as joyful feelings of the learners during the learning process and evaluation, and improved motivation while learning physics. High interest or tendency of the learners to use various game products could be an innovation for physics learning [13]. Educational games are useful to invite learners to play the game wisely and appropriately. The learners do not only use the game as an amusement media to spend their time but also as a useful learning means.

The development of educational game learning media should have interesting designs to teach the learners to understand physics material with the assistance of learning-by-playing. These efforts could improve learning achievements. One of the educational games to develop as a learning means is Physics Monopoly (Mofis). The innovative learning media development, Mofis, could improve the learners' creativity in learning and make the learning atmosphere meaningful. Besides that, this learning media is familiar to learners so they could easily use the game.

Mofis is a gaming media adapted from a Monopoly game with some modifications based on physics learning media. The game consists of a board with various activities, dice, pion, and money toys to share only for learners with correct answers, and some question items based on the materials of the lesson [9]. A monopoly could be a medium to train the learners' memory and material mastery. The game could also encourage the learners' bravery to express their arguments, train conceptual mastery, and comprehend the learning material [14]. A monopoly game, such as physics learning media, could provide positive results such as improving the learning activities and learning achievements of the learners [15].

The teaching-learning process could run effectively and efficiently with the support of relevant learning media. Therefore, familiar physics learning media is important for learners. This research produces an educational game in the form of a physics monopoly, Mofis, to make the learners understand the physics material in the classroom. This product could attract learners and lower boredom while learning physics. Besides that, the researchers attempted to determine the quality and reliability of the developed game, Physics Monopoly (Mofis), under the materials of momentum and impulse for SHS/ISHS learners; and the learners' responses toward the implementation of the developed product as the physics learning media.

B. Method

In this research, the researchers applied the Research & Development model. This Research & Development attempts to produce certain useful products and examine the products to determine their effectiveness and reliability [16]. The product of the research is the educational game of physics monopoly, Mofis, for SHS and ISHS learners under the materials of momentum and impulse. The applied procedure is 4D as suggested by Thiagarajan [17]. This 4D model consists of defining, designing, developing, and disseminating stages. However, in this current research, the stage stops until the development stage.

The applied data collection methods were interviewing, observing, and distributing the questionnaire. The researchers interviewed the physics teachers to gain preliminary data about the development necessity from the research sites, the SHS and ISHS. From the interview, the researchers found the problems to investigate. The researchers observed to measure the aspects of learning, necessity, and skill attitudes from the learners. Then, the researchers shared the questionnaire to measure the validity of the developed media.

The applied data analysis technique to validate the instrument and the media was Aiken's V formula calculation. This formula is useful for calculating the content-validity coefficient based on the evaluations of the n-experts toward a certain item [18]. Here is the applied formula.

$$V = \frac{\Sigma s}{[n_1(c-1)]} \tag{1}$$

with

$$s = \mathrm{r} - I_0 \tag{2}$$

Remarks:

n_1 : the numbers of the raters (assessment)
s : the rater scales
c : the categories of the assessed criteria
r : the first-assessed criterion
I_0 : the lowest category

The applied data analysis technique was useful in calculating the product quality evaluations based on the material and media experts, teachers, and learners' response calculations toward the media as suggested by Sudjana (2009:131).

$$X = \frac{\Sigma x}{N.n} \tag{3}$$

Remarks:

X : Mean score
ΣX : Score total

N : The raters

n : The question items

C. Result and Discussion

The experts evaluated the developed learning media, the physics monopoly game (Mofis). The researchers expected the developed product to be applicable for SHS learning under the materials of momentum and impulse. In this research, the researchers applied a 4D model to produce the physics monopoly game (Mofis). Here are the results of each R&D stage.

The Defining Stage

The defining stage determines and defines the instructional conditions and necessities of the learning process. This stage leads to the learning objectives and learning material scopes. This stage is also useful to analyze the learners' necessities, materials, and objective formulations. The applied analyses found the absence of media implementation in school learning. Most learning relied on the lecturing method that made one-way communication from teachers to the learners. Thus, the learners were passive in the learning. The learners also had no interest in learning physics and tended to play games while the classroom was learning. The researchers expected the developed educational game of Physics Monopoly could solve the existing problems.

The Designing Stage

The analysis results, based on the defining stage, were useful in designing the learning media product, the physics monopoly (Mofis). In this stage, the researchers arranged the research instruments, selected the media and the format, and created a preliminary design and prototype. The researchers validated, revised, and assessed the physics monopoly base don the defining stage in the subsequent process. Here is the design of the physics monopoly learning media (Mofis).

Figure 1. The Physics Monopoly Game Board

The Development Stage

This stage produced the educational game learning, the first draft of Mofis, to validate. This stage has two activities: expert appraisal to validate the product reliability; and developmental testing or product trial run. The stage begins by validating the first draft of Mofis. The experts then shared the suggestions for further revisions. The validations of the expert materials are useful to obtain the content material adjustment within the Mofis before being assessed qualitatively. Based on the analyses, the developed physics monopoly, Mofis, has high validity based on the result of material experts with a score of 0.88.

The Mofis validation by the media experts is useful to find out the relevance of Mofis with the visual and implementation aspects. The analysis results found that Mofis had high validity based on the media experts with a mean score of 0.90. The validators also suggested and stated that the developed Mofis was valid with minor revisions.

Based on the validation and the first revision, the researchers revised the first draft of Mofis into the second draft. Then, the researchers evaluated the quality of the developed learning media by involving two material experts, two media experts, and a physics teacher at SHS. This procedure was useful to determine the developed learning media, Mofis. The experts also shared their evaluation, suggestions, and recommendations for further Mofis revisions. This assessment process applied a previously validated instrument.

Table 1. The Evaluation Results of the Material Experts

The Evaluation Aspect	The Score Mean	The Criteria
The Aspect of Material Validity	3.67	Extremely Excellent
The Language Aspect	3.75	Extremely Excellent
The Aspect of Question Item Display	3.63	Extremely Excellent
Mean	3.68	Extremely Excellent

The quality assessment by the material experts consisted of three aspects. They were the material, language, and question item display validity. The researchers had the experts score the product based on a 4-sore Likert scale. The obtained score from the material expert is 3.68, categorized as extremely excellent. The result shows that Mofis, based on the material aspect, has extremely excellent quality. The assessment result of the material expert found the language aspect had the highest score mean, 3.75 with extremely excellent criterion. The results show that the language is communicative and understandable to share the materials. The applied sentences are relevant to the General Guideline of Indonesian Language Spelling, PUEBI. The material validity aspect has two indicators: the material relevance and the correctness of the learning material. This aspect obtains a mean score of 3.67 with the criterion of extremely excellent. The results show that the materials of Mofis are relevant to the

core competencies, basic competencies, indicators, and learning objectives of the revised 2013 curriculum.

Table 2. The Results of the Media Expert Evaluation

The Evaluation Aspect	The Score Mean	The Criteria
The Visual Aspect	3.72	Extremely Excellent
The Media Implementation Aspect	3.33	Extremely Excellent
Mean	3.53	Extremely Excellent

The evaluation results by the media experts are based on the visual and implementation aspects. The given score is based on the 4-score Likert scale. The obtained mean score of the media experts is 3.53 with the criterion of extremely excellent. These results show that the developed Mofis, based on the media aspect, has extremely excellent quality. The evaluation results of the media experts found the visual aspect had the highest score mean, 3.72, based on three indicators: textual readability, color selection, and design quality. The results show that the text display of the developed Mofis is clear and readable. Besides that, the color composition of Mofis is harmonious and attractive. Then, the color display is in contrast with the applied letter colors. Mofis has excellent design quality based on the figure display, figure-material relevance, tidiness, attractiveness of Mofis design, and the package. Therefore, the visualizations of Mofis are attractive and interesting for the learners.

Table 3. The Assessment Results of Physics Teachers at SHS

The Evaluation Aspect	The Score Mean	The Criteria
The Visual Aspect	4.00	Extremely Excellent
The Aspect of Material Validity	3.67	Extremely Excellent
The Language Aspect	4.00	Extremely Excellent
The Aspect of Question Item Display	3.50	Extremely Excellent
The Learning Implementation Aspect	4.00	Extremely Excellent
Mean	3.83	Extremely Excellent

The evaluation results from the teachers show that the visual, language, and learning implementation aspects have the criterion of extremely excellent with a mean score of 4.00. The visual aspect consists of some indicators, such as Mofis display based on the design, color composition, and textual display. The results show that the physics teachers agree with the developed Mofis based on the visual aspect. They found the developed product had an attractive and tidy design, harmonious color composition, relevant figure implementation based on the material, and clear and readable textual presentations. The obtained criteria show an extremely excellent category based on the language aspect. The applied language is excellent, communicative, and understandable. Besides that, the applied sentences have excellent order based on the General Guideline of Indonesian Language Spelling,

PUEBI. Then, from the learning implementation aspect, the result shows an extremely excellent criterion. Thus, the developed Mofis could motivate the learners to learn physics based on the necessities of the learners. Mofis could also improve the activity and participation of the learners in learning and create a new atmosphere of learning physics.

The evaluation of Mofis led to the third draft of Mofis. This draft was useful for the subsequent trial run. The researchers tried the product in the second stage, the limited trial run. This stage involved nine learners of SHS. Then, the large-scale trial run involved 22 learners of SHS. The trial run process with the third draft of Mofis received some revision processes based on the assessment.

Table 4. The result of the Limited Trial Run

The Evaluation Aspect	The Score Mean	The Criteria
Display	3.22	Agree (A)
Material	3.22	Agree (A)
The Implementation	3.06	Agree (A)
Learning	3.33	Extremely Agree (EA)
Mean	3.24	Agree (A)

Table 5. The result of the Large-Scale Trial Run

The Evaluation Aspect	The Score Mean	The Criteria
Display	3.31	Extremely Agree (EA)
Material	3.21	Agree (A)
The Implementation	3.30	Extremely Agree (EA)
Learning	3.34	Extremely Agree (EA)
Mean	3.24	Agree (A)

In general, the obtained scores from the limited trial run and the large-scale trial run are 3.24 with the criterion of agree and 3.28 with the criterion of extremely agree. This matter shows the learners agree with the attractive Mofis display, the material-conceptual relevance, the ease of Mofis implementation, and the attractive Mofis implementation in the learning. Thus, the developed educational game, Mofis, could be accepted properly by learners for learning process purposes and as the learning media. The developed media could create a joyful learning atmosphere and make the learners interested. Hidayati et al (2022) found that physics monopoly learning media could be an alternative to realize relaxing and joyful learning. The learners could learn and solve problems based on the given cards and apply the prior knowledge and material from the books and the Internet. Learners would be interested to join and listen to the learning because they found the learning challenging. They could also explore their knowledge to answer the questions based on the cards.

D. Conclusion

This research produces an educational game in the form of a physics monopoly, Mofis, with the materials of momentum and impulse to apply in the learning process. The results show the physics monopoly, Mofis, based on the experts of material and media and the physics teachers of the SHS, with scores of 3.68; 3.53; and 3.83. All scores indicate extremely excellent (EE). Based on the learners' responses toward the developed media, during the limited trial run, the obtained mean score is 3.24 with the criterion of agree (A). On the other hand, the large-scale test obtained a mean score of 3.28 with the criterion of extremely agree (EE).

Acknowledgements

This research received various guidance and assistance from many parties. Therefore, the researchers would like to express their gratitude to all participating parties in this research.

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