Volume 8 Number 3, December 2023, pp. 344-355
P-ISSN:2477-7935
E-ISSN:2548-6225
DOI: 10.59052/edufisika.v8i3.29670

PHYSICS EDUCATIONAL GAME CONTAINS SCIENTIFIC LITERACY AND ETHNOSCIENCE ON NEWTON'S LAW OF MOTION

Tegar Putra Socrates[1,*], Riziqul Ikram[1], Renol Afrizon[1], Rahmat Hidayat[1], Hidayati[1], Nur Erwani Rozi[2]

[1] Department of Physics, Faculty of Mathematics and Natural Sciences, Universitas Negeri Padang, Sumatera Barat, Indonesia
[2] Division of Education Sponsorship, Ministry of Education Malaysia, Putrajaya, Malaysia
Corresponding author email: tegarsocrates084@gmail.com

Article Info
Received: 23 Oct 2023
Revised: 21 Nov 2023
Accepted: 28 Nov 2023
OnlineVersion: 03 Dec 2023

Abstract :
The development of science and technology has changed the demands of the world of education. The national education system requires students to have scientific literacy competencies. The independent curriculum emphasizes the formation of Pancasila student profiles. One of the efforts made is to integrate local wisdom in learning. This curriculum adjustment requires the use of technology in learning. One solution is to develop an educational physics game. The study aimed to determine the characteristics, validity, and practicality of Physics educational games containing scientific literacy and ethnoscience. The research included the type of development research using the Plomp model. Research is limited to the stage prototyping phase at the small group practicality stage. The data source was obtained from the results of expert validation by Physics lecturers Faculty of Mathematics and Natural Sciences UNP. The source of practical data was acquired from grade X students of Senior High School 1 Padang. The data collection instruments in this study are validity test sheets and practicality test sheets. The data analysis technique used is descriptive statistical analysis. Based on the study results, the material validity test obtained a value of 0.88, and the media validity has a value of 0.92, each categorized as high validity. The results of the practicality test got a one-to-one stage value of 91.88 and a small group of 90.37; each categorized as very practical. It was concluded that physics educational games are valid and practical to use as a medium for learning Newton's laws of motion.

Keywords: Educational Game, Ethnoscience, Scientific Literacy

This is open access article under the CC BY-NC-SA licence

INTRODUCTION

The rapid progress of science and technology today encourages government regulation in various aspects of life. The tendency to use the symbol "e," which is interpreted as electronic, has emerged and is applied to all aspects of life, including education, such as e-education, e-government, e-

learning, and so on (Tekege, 2017). The curriculum is developed to meet goals based on changing demands and improve the quality of education because the curriculum is the heart of education (Febriana, Sugiman, & Wijaya, 2023).

The current independent curriculum is more basic, emphasizing forming the profile of Pancasila students. This means that graduates will have knowledge competencies and that characters based on the nation's personality must still be superior (Santika, 2022). The Merdeka Curriculum has main characteristics, namely project-based learning to develop soft skills and character, and focuses on seven main themes, including the integration of local wisdom in learning (Festiyed et al., 2022).

Local wisdom owned by the community must be studied scientifically so that the values of local wisdom can be reconstructed into scientific science. The term ethnoscience then emerged as an approach to blending culture and science. Sudarmin et al., (2020) stated that an ethnoscience-based learning approach can overcome the separation between science and community culture. The purpose of science education is to improve the competence of students to meet their life needs in various situations; one of them is related to scientific literacy competence. Indonesia is a country rich in local culture. However, global technological developments are beginning to erode the values of your cultural wisdom (Socrates et al., 2022). To preserve local cultural values, it is necessary to apply media and technology in the learning process.

Learning media has an essential position in the learning process. Media is essentially one component of the learning system. As a component, media should be an integral part and must be in accordance with the learning process (Rahim et al., 2019). One of the learning media that teachers can develop is smartphone-based learning media. Because many students use smartphones to play games and social media, this will interfere with their learning, because their concentration will decrease or decrease (Prasetyo et al., 2023). To overcome this, it would be nice for smartphones to be used in learning so that students can learn independently through their smartphones. One of the learning media that can be accessed easily through smartphones is educational games.

Educational games are designed to teach users a particular learning material, so students still learn even though they are playing (Ayu et al., 2017; Arifah et al., 2019). Educational games aim to foster students' interest in learning material in which there is a game so that with a feeling of pleasure, it is hoped that students can more easily understand the subject matter that the teacher has delivered in learning activities (Windawati & Koeswanti, 2021; Afrizon et al., 2023). One of the advantages of educational games is the use of animation that can improve memory so that students can store subject matter for a longer time compared to conventional teaching methods (Santoso & Wuryandani, 2020).

Physics learning in schools is rarely exemplified by the application of material in everyday life. So that students feel that Physics is a lesson that is not useful after graduating later (Rahmat et al., 2017). In addition, learning physics is also considered difficult because of the many formulas and calculations involved. As revealed by Suparno (2009), some high school students do not like Physics and choose majors that do not have Physics lessons because Physics is considered scary and challenging to learn, and there are many calculations and formulas. Some high school students complain of difficulties in learning physics, so there are often mistakes when solving problems. They feel it is better to avoid physics than encounter difficulties if they study it. If they are forced to study Physics, it is only an obligation at school, not to understand it (Suroso, 2016).

Physics material is related to everyday life, so teachers must be able to explain the concept in natural form. Newton's law of motion is a high school physics material that is difficult for students to learn; it is full of formula calculations and abstract (Sari et al., 2018). As a result, many students are too lazy to learn Physics because there are too many formulas, and they feel bored (Astuti et al., 2017; Hidayati & Aslam, 2021). This results in teachers' need for special efforts so that students easily understand the material. One of the efforts made is to make the concept of Physics clear, know its application in life, and can be visualized (Syafi'i & Nasir, 2016).

Based on observations at SMAN 1 Padang class X, teachers have not optimally utilized the facilities available at school. Teachers are more likely to explain when learning so that interaction is more dominant in one direction. In physics learning, teachers usually use lecture methods and whiteboard media. After the material is finished, the teacher will give practice questions. Sswa is only required to listen and record explanations from the teacher so that students do not develop their abilities. This impacts the lack of student activity in the learning process. Furthermore, students become more

enthusiastic about learning using learning media (Novitasari et al., 2020). The next problem is that Android-based technology learning media has not been developed in schools (Socrates et al., 2023).

Based on these problems, it is necessary to develop technology-based Physics learning media in the form of Physics educational games. Physics educational game developed contains scientific literacy and ethnoscience on Newton's laws of motion. Through this Physics educational game containing scientific literacy and ethnoscience, it is hoped that it can make students more interested in learning Newton's law material about motion as well as one of the media to preserve local culture. This study aims to determine the characteristics, validity, and practicality of Physics educational games containing scientific and ethnoscientific literacy on Newton's laws of motion.

RESEARCH METHOD

This type of research is development research (Development Research) which aims to develop and validate products suitable for use—product development using the Plomp model. The Plomp model consists of three stages of research, namely: (1) preliminary research, (2) development/prototyping phase, and (3) assessment phase (Plomp &; Nieveen, 2013).

1. Preliminary Research Phase

The preliminary research stage is also known as needs analysis or problem analysis. At this stage, journal analysis is carried out to identify the problems of learning physics. Then a needs analysis was carried out, including material analysis, concepts, and characteristics of high school students as game design guidelines.

2. Development/Prototyping Phase

a. Designing Physics Educational Games

The educational games to be developed are arranged using Unity 3D. The steps in designing a physics educational game are as follows: Making backgrounds and object animation using the Corel Draw application, prototyping, coding, and making an Apk.

b. Formative Evaluation and Prototype Revision

This activity aims to test the validity and practicality of the prototype. The validity test is carried out on two aspects, namely the material aspect and the media aspect. The practicality test is carried out up to the small group stage. The evaluation carried out refers to the Tessmer diagram in Figure 1.

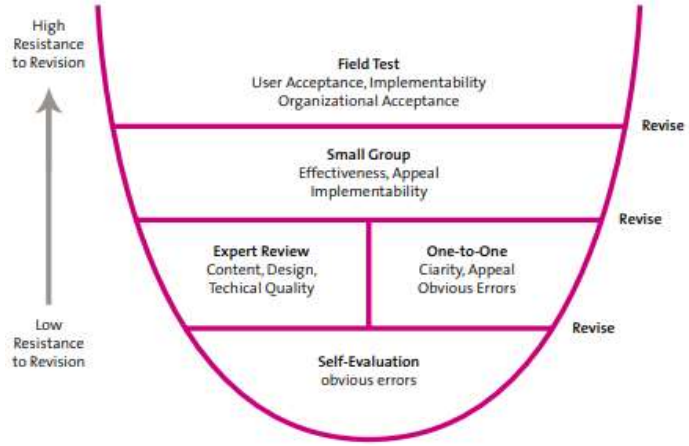

Figure 1. Formative Evaluation (Tessmer, 1993, in Plomp 2013)

The following stages are carried out in the evaluation and revision of the prototype based on Figure 1, including:

1) *Self–Evaluation*

Self-evaluation is carried out to examine, improve, and re-observe all parts of the Physics educational game. The instrument used is a self-assessment instrument.

2) *Expert Review*

Expert review is a validity test stage by experts on physics educational games. 6 lecturers of Physics FMIPA UNP carried out validation. Two validation tests were carried out, namely the material

expert validation test and the media expert validation test. Validator suggestions are used to revise game prototypes.

3) *One-to-One Evaluation*

The one-to-one evaluation was conducted to test the practicality of Physics educational game products. The practicality test was conducted on three students of SMAN 1 Padang representing low, medium, and high abilities

4) *Small Group Evaluation*

Small group evaluation was conducted to test the practicality of Physics educational game products. The practicality test was conducted on nine students of SMAN 1 Padang, representing low, medium, and high abilities.

In this research, the instruments and data collection techniques used are as follows

Self-Evaluation Sheet

Self-evaluation aims to see visible errors from the game's initial design, including completeness and suitability to the format.

Validity Instrument Sheet

The validity sheet is arranged based on the aspects to be assessed from the Physics educational game developed. In general, two validation tests are carried out, namely validation tests by material experts and validation tests by media experts.

Practicality Instrument Sheet

The practicality sheet is used to explore students' views on Physics educational games as a learning medium used in Newton's Law of Motion material.

Data analysis techniques used in this research include:

Data Analysis Technique

1. Product Validity Analysis

The validity of the developed product is obtained from the validity instrument filled in by lecturers of the Department of Physics UNP. The validity test assessment questionnaire is prepared based on the Likert scale. The data obtained were analyzed using the validity index proposed by Aiken. The following is the equation for the validity index of Aiken's V (V) index items:

$$V = \frac{\Sigma s}{n(c-1)} \quad (1)$$

$$s = r - l_0 \quad (2)$$

Information:
V = Rater deal index
l_0 = The lowest validity assessment number (in this case = 1)
c = The highest number of validity assessments (in this case = 4)
r = Number given by an appraiser
n = Number of raters

After obtaining the rater agreement index value, the category of the index value is determined—results of category provisions based on Aiken's V Index, as shown in Table 1.

Table 1. Conditions Based on Aiken's V Index

Interval	Validity Category
≤ 0.4	Less
0.5 < V ≤ 0.8	Medium
0.8 < V	High

Products are declared suitable for use if the validity is in the medium and high categories (Retnawati, 2016).

2. Product Practicality Analysis

Practicality to assess the practicality of the game developed is seen from the results of student questionnaires. The practicality test assessment questionnaire is prepared based on the Likert scale. The equation analyzed the data obtained from the practicality test:

$$Value = \frac{Total\ Score}{Maximum\ Score} \times 100 \quad (3)$$

The assessment of practicality is determined based on the interpretation criteria of the scores obtained in Table 2.

Table 2. Product Practicality Criteria

Level (%)	Category
86.0 – 100.0	Very Practical
76.0 – 85.0	Practical
60.0 – 75.0	Quite Practical
55.0 – 59.0	Less Practical
≤ 54.0	Impractical

Products are declared practical and suitable for use if the assessment is on practical and very practical criteria (Purwanto, 2010).

RESULTS AND DISCUSSION

The results of the development in this study, namely a physics educational game with the aim of scientific literacy and ethnoscience using unity by making it into the android package (APK) format. The educational game has four main menus, including (1) competence, (2) material, (3) evaluation, and (4) instructions. Each part is connected to each other so that users can also get results obtained from each activity they do through the exercise menu. The following is the cover of the Physics educational game that has been made can be seen in Figure 1.

Figure 2. Cover View

The main menu page contains several features that are shortcuts to open the application menu view. The features contained in the main menu are competencies, materials, evaluations, instructions, compilers, and summaries. The main menu display can be seen in Figure 3.

Figure 3. Main Menu Display

The main menu contains menu features that are contained and can be accessed with the use of educational games. There are four main features: guidance, competence, material, and evaluation. First, the hint feature contains steps that users should understand before using educational games. There are two clues, namely learning instructions and game instructions. Second, the competency feature contains the competencies that students must achieve on Newton's law of motion material based on the Independent Curriculum. Third, the features of matter consist of several levels of Newton's Law of Motion. Finally, the evaluation feature contains practice questions that will hone skills and measure the extent of students' understanding of the material that has been learned. The display of material-level choices from the Physics educational game can be seen in Figure 4.

Figure 4. Menu Display Select Level

At each level, the user must complete the challenges in that level using the tools provided. Each level of the game is designed with scientific literacy and ethnoscience for the integrated scientific literacy part displayed after the user obtains the key. Furthermore, for the scientific context, the beginning of each level contains local cultural information relevant to the physics concepts of each material. Here's a description of the gameplay of Physics education at each level level, namely:

Table 3. Description of Levels in Physics Education Game

Levels	Description
Level 1	Force concept material. The user must pick up the sales results deposited at the Mak Upik stall at this stage. After picking up the sales, the user must immediately go home to help Dad.
Level 2	Gravity and force in daily life material. At this stage, the user must help his mother deliver the goods to Mak Wati's house.
Level 3	Friction and rope tension forces material. Because the drain in the house is broken, the user has to go to the well. Draw water in the well using pulleys.
Level 4	Centripetal force material. Users must go to the night market because tomorrow is a holiday. Then, users visit one of the amusement rides.
Level 5	Newton's first law material. Dad asked the user to deliver the key that was left at home to the art studio.
Level 6	Newton's second law material. The father asked the user to deliver Mr. Basri's table by car. On the way, there are mothers who have difficulty carrying their luggage. The mother's house was before Mr. Basri's house.
Level 7	Newton's Third law material. Users have a mission to go to the next village to visit traditional events. To get to the next village, the user must cross the river.
Level 8	The application of Newton's laws material. The user has a mission to visit one of the shopping centers. Then, the user takes an elevator to one of the shopping centers.

This game's mission is to provide students with knowledge to understand Newton's laws of motion material and increase students' scientific and ethnoscientific literacy. Users must collect keys to increase energy and collect information to complete game missions. Users must complete game challenges at each level, and to be able to complete a level, users must answer quiz questions correctly. Evaluation questions in educational games demand high accuracy and reasoning power from users. This educational game can train players in practicing test preparation questions, tests, and the like (Parlika et al., 2019). In addition, this game also contains ethnoscientific information related to the concept of the material discussed at each level. This is made so that students can understand Newton's Law material about motion more easily and know the application of material in everyday life. Here are some views of educational games at level 1, namely:

Figure 5. Game Mission Display

Figure 6. Game Challenge Display

Games that have been developed are then tested to find out whether the educational games that have been made are in accordance with the needs. The tests carried out consist of two tests: the validity test and the practicality test. The validity test was carried out by material experts and media experts, each test by three lecturers of the Department of Physics FMIPA UNP. The validity test by material experts has three assessment indicators, namely, 1) material substance, 2) learning game design, and 3) language. The following results of the plot of the validity value of material experts in the Physics educational game can be seen in Figure 7.

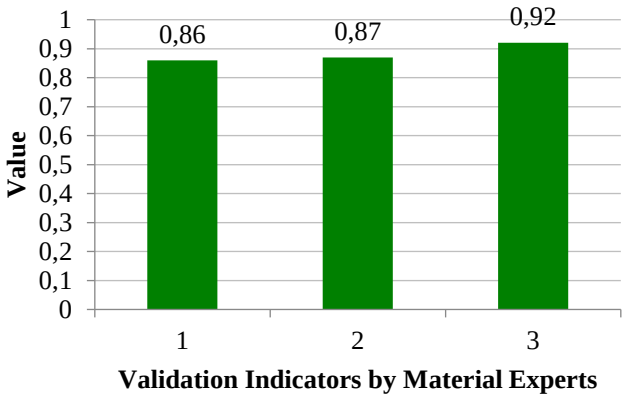

Figure 7. Results of Validation Indicators by Material Experts

Figure 7 shows that the average score of each aspect of material expert validity in the Physics educational game. The value of the substance aspect of the material is 0.86, learning game design is 0.87, and language is 0.92. The overall average value of the material expert validity indicator in the Physics educational game was 0.86. Thus, the material in the physics educational game containing scientific literacy and ethnoscience is valid in a high category.

The results of the material validity test obtained results with high validity categories. This is because the language used is in accordance with the target user, communicative so that users are more motivated to learn and understand learning material. However, there is something to note again in the presentation of educational games: there are examples of questions and quizzes that are less relevant to the game's adventure plot, and there are still wrong concepts, similarities, and symbols that need to be corrected.

The validation test by media experts has three assessment indicators, namely 1) display, 2) device or software, and 3) audio-visual communication. The results of the plot of the validity value of media experts on the game can be seen in Figure 8.

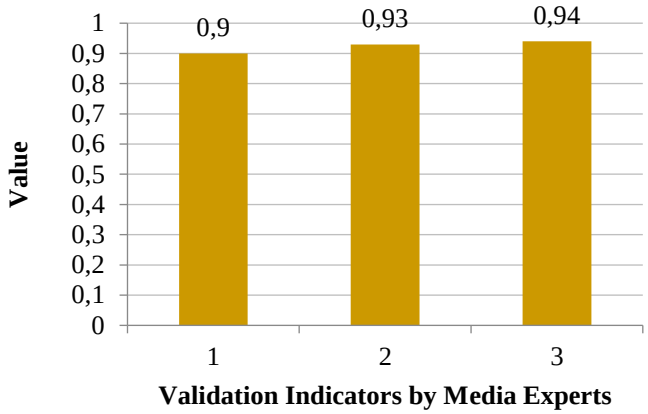

Figure 8. Results of Validation Indicators by Media Experts

Figure 8 shows that the average score of each aspect of media expert validity in the Physics educational game. The display aspect value is 0.90, the device or software is 0.93, and the audio-visual communication is 0.94. The average score of the media expert validity indicator in the Physics educational game was 0.92. Thus, the media component in the Physics educational game containing scientific literacy and ethnoscience on Newton's laws of motion is valid with a high category.

The results of the media validity test obtained results with high validity categories. This is because the educational games developed are proportional in terms of depiction of objects, sounds, easy-to-understand language, and well-functioning navigation menus. However, the developed educational game can only be accessed through android devices. In addition, validators suggest that the game levels are allowed to be accessed sequentially so that students understand the material more sequentially.

Based on the assessment of material validation tests and media validation tests, it is obtained that educational games have high validity. Similar results were obtained by Rusadi, et al (2017) when validating an Android-based educational game on Mathematical logic material. The educational game is valid with an outstanding category. The results of Panjaitan et al. 's (2020) research on interactive multimedia based on educational games as a learning medium for Respiratory System material in class X high school are categorized as valid by material experts and media experts. That is, educational games that are made can be used as learning media.

The practicality test of this game was carried out on three students at the one-to-one stage and nine people at the small group stage. The practicality test is done after the validity test where the game is revised based on suggestions from validators. Then, the revised game is used in the learning process. After completing the learning process, students are asked to fill out a practicality questionnaire. The results of the practicality test for the one-to-one stage can be seen in Table 4.

Table 4. Results of one-on-one Practicality Test Indicator

Value	Aspects				Practicality
	Ease of Use	Attraction	Efficiency	Benefit	
Mean	83.33	96.67	91.66	95.85	91.88

Table 4 shows that the average score of each component on the practicality of the Physics educational game at the one-to-one stage. The component value of ease of use is 83.33, attractiveness is 96.67, efficiency is 91.66, and benefits are 95.84. Based on these values, it can be stated that the practical value of physics educational games in the category is efficiency. The overall average value of the practicality indicator was 91.88. Thus, Physics educational games containing scientific literacy and ethnoscience on Newton's laws of motion material have had practicality with a convenient category at the one-to-one stage. The results of the practicality test for the small group stage can be seen in Table 5.

Table 5. Results of *Small Group* Practicality Test Indicator

Value	Aspects				Practicality
	Ease of Use	Attraction	Efficiency	Benefit	
Mean	81.85	95.66	90.33	93.67	90.37

Table 5 shows that the average score of each component in the practicality of Physics educational games at the small group stage. The value of the ease of use component is 81.85; attractiveness is 95.56; efficiency is 90.33; and benefits is 93.67. Based on these values, it can be stated that the practical value of Physics educational games in the category is very practical. The overall average value of the practicality indicator was 90.37. Thus, Physics educational games containing scientific literacy and ethnoscience on Newton's laws of motion have had practicality with a very practical category at the small group stage.

The practical results of the Physics educational game at the one-to-one stage are in the very practical category. Three of the four aspects of the assessment obtained an average above 90. At the same time, one other aspect obtained a score of around 80 on the aspect of ease of use. This is because accessing the navigation menu of educational games sometimes crashes, so it needs to be pressed repeatedly to complete game missions.

Based on the one-to-one stage practicality test results, it was determined that physics educational games are categorized as very practical. Similar results were obtained by Hidayani, et al (2020) when testing the game using the Lectora Inspire application on chemical equilibrium materials. These educational games are categorized as very practical by teachers and students. The results of Fitri & Rakimahwati's (2021) research on interactive multimedia based on educational games based on local culture, Sumbang Duo Baleh, received a very practical assessment by teachers. That is, users can appropriately use the educational games.

The development of this physics educational game took a long time to complete, so it is categorized as suitable for use as a learning medium in schools. The Physics educational game is currently only accessible through Android devices and is not yet available on iOS. This study's development of physics educational games is limited to Newton's laws of motion. Therefore, it is necessary to develop Physics educational games for other physics materials. In the future, other researchers can continue to the assessment phase for maximum results.

CONCLUSION

The characteristics of physics educational games containing scientific literacy and ethnoscience that have been produced consist of covers, competencies, materials, sample questions, quizzes, summaries, and references. The results of the validity test of the Physics educational game containing scientific and ethnoscientific literacy on Newton's law of motion material have a high validity value in aspects of matter and media validity. The results of the practicality test of Physics educational games have a practical value that is classified as very practical at the one-to-one and small group stages. Physics educational games can be applied as a medium for Newton's laws of motion.

ACKNOWLEDGMENTS

The researcher expressed his high appreciation and gratitude to the Institute for Research and Community Service, State University of Padang for funding this research with research contract number: 960/UN35.13/LT/2022. In addition, the researcher also expressed his gratitude to Senior High School 1 Padang.

REFERENCES

Afrizon, R., Hidayati., & Novitri, L. (2023). Analysis of senior high school students' motivation to study physics in Padang city for the development of physics learning games with scientific literacy. *AIP Conference Proceedings*, *2619*(1). https://doi.org/10.1063/5.0123730

Arifah, R. E. N., Sukirman, S., & Sujalwo, S. (2019). Development of bilomatics educational game to improve student learning outcomes in grade 1 Elementary School mathematics subjects. *Journal of Information Technology and Computer Science*, *6*(6), 617–624. https://doi.org/10.25126/jtiik.2019661310

Astuti, I. A. D., Sumarni, R. A., & Saraswati, D. L. (2017). Development of Android-based mobile learning physics learning media on static fluid material. *Scientific Journal of the Education Profession, 3*(1), 57–62. https://doi.org/10.29303/jipp.v7i1.381

Ayu, S., Sutardi., & Tajidun, L. (2017). Design an educational game of Southeast Sulawesi cultural puzzle with Fisher-Yates Shuffle algorithm. *Semantics, 3*(1), 29–38. http://dx.doi.org/10.55679/semantik.v3i1.2588

Febriana, R., Sugiman, S., & Wijaya, A. (2023). Analysis of the Implementation of Differentiated Learning in the Implementation of the Independent Curriculum in Middle School Mathematics Lessons. *International Journal Of Humanities Education and Social Sciences*, *3*(2). https://doi.org/10.55227/ijhess.v3i2.549

Festiyed, F., Mikhayla, M. E., Diliarosta, S., & Anggana, P. (2022). Understanding of high school biology teachers at DKI Jakarta driving school on the ethnoscience approach to the independent curriculum. *Journal of Education and Culture, 7*(2), 152–163. https://doi.org/10.24832/jpnk.v7i2.2993

Fitri, R., & Rakimahwati, R. (2021). Educational game based on local culture donates duo baleh to improve children's interpersonal intelligence. *Journal of Obsession: Journal of Early Childhood Education, 6*(1), 239–251. https://doi.org/10.31004/obsesi.v6i1.1220

Hidayani, R., Sabekti, A. W., & Yulita, I. (2020). The practicality and effectiveness of educational game developed using lectora inspire in chemical equilibrium. *JCER (Journal of Chemistry Education Research), 4*(2), 58–62. https://doi.org/10.26740/jcer.v4n2.p58-62

Hidayati, I. D., & Aslam, A. (2021). The effectiveness of online Quizizz application learning media on students' cognitive development. *Journal of Pedagogy and Learning, 4*(2), 251–257. https://doi.org/10.23887/jp2.v4i2.37038

Syafi'I, M., & Nasir, M. (2016). Design and development of interactive multimedia learning physics visualization of regular circular motion in senior high school (SMA). *Journal of Education, 7*(2), 86–96. http://dx.doi.org/10.31258/jp.7.2.86-96

Novitasari, A. T., Sari, P. I., & Miftah, Z. (2020). Training on creating information Technology-Based interactive learning media. *Journal Of Devotion To You Negeri, 4*(1), 66–73. https://doi.org/10.37859/jpumri.v4i1.1848

Panjaitan, R. G. P., Titin, T., & Putri, N. N. (2020). Interactive multimedia based on educational games as a learning media for respiratory system material in class xi senior high school. *Indonesian Journal of Science Education, 8*(1), 141–151. https://doi.org/10.24815/jpsi.v8i1.16062

Parlika, R., 'Azizah, L., Nugroho, C. A., Putri, A. D., & Handono, F. S. (2019). Android-based physics learning game "Brain Teasers" with App Inventor 2. *E- Journal: Spirit Pro Patria, V*(1), 1–10. https://doi.org/10.31090/narodroid.v4i2.731

Plomp, T., & Nieveen, N. (2013). *An Introduction to Educational Design Research*.

Prasetyo, A., Rondli, W. S., & Ermawati, D. (2023). The impact of online game play on the learning achievement of elementary school students. *Journal of Educatio FKIP UNMA, 9*(1), 333–340. https://doi.org/10.31949/educatio.v9i1.4733

Purwanto, P. (2010). *Principles and Techniques of Teaching Evaluation*. Bandung: Remaja Rosdakarya.

Rahim, F. R., Suherman, D. S., & Murtiani, M. (2019). Analysis of Teacher Competence in Preparing Information Technology-Based Learning Media in the Industrial Revolution Era 4.0. *Jurnal Eksakta Pendidikan (JEP), 3*(2), 133. https://doi.org/10.24036/jep/vol3-iss2/367

Grace, A., Tandililing, E., & Oktavianty, E. (2017). Analysis of student errors in solving questions on kirchoff's law material at SMAN 1 Meranti. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa (JPPK), 6*(10), 2–16. https://dx.doi.org/10.26418/jppk.v6i10.22125

Retnawati, H. (2016). *Quantitative Analysis of Research Instruments*. Yogyakarta: Parama Publishing.

Rusadi, A. P., Noto, M. S., & Pramuditya, S. A. (2017). Design of learning media based on educational games on quadrangular material for junior high school students class VII. *Proceedings of the National Seminar on Mathematics Education (SNPM) Uninus*, 1–13.

Santika, I. W. E. (2022). Strengthening the values of Balinese local wisdom in forming the Pancasila Student Profile. *Journal of Education and Counseling, 4*(4).

Santoso, R., & Wuryandani, W. (2020). Development of PPKn teaching materials based on local wisdom to increase cultural resilience through understanding the concept of diversity. *Journal of National Resilience*, *26*(2), 229–248. https://doi.org/10.22146/jkn.56926

Sari, A. L. R., Parno, R., & Taufiq, A. (2018). Understanding the concepts and difficulties of high school students on newton's law material. *Jurnal Pendidikan: Teori, Penelitian dan Pengembangan*, *3*(10), 1323–1330. http://dx.doi.org/10.17977/jptpp.v3i10.11663

Socrates, T. P., Afrizon, R., Hidayati, H., & Hidayat, R. (2023). The needs analysis for an educational physics game with scientific literacy and ethnoscientific content. *Journal of Physical and Technology Education*, *9*(1), 151–162. https://doi.org/10.29303/jpft.v9i1.5079

Socrates, T. P., Ihsan, H., Rahmayani, M., & Rahim, F. R. (2022). Design of culture based physics mobile learning media on circular movement materials for class X SMA Students. *Epicentrum*, *1*(2), 5–13. https://doi.org/10.54482/epicentrum.v1i02.164

Sudarmin, S. (2014). *Character Education, Ethnoscience, and Local Wisdom: Concepts and Applications in Research, and Science Learning*. Semarang: CV. Self-help Manunggal.

Sudarmin, S., Prasetya, T. A., Diliarosta, S., Pujiastuti, R. S. E., & Jumini, S. (2020). The design of ethnoscience-based inquiry learning for scientific explanation about taxus sumatrana as cancer medication. *Journal for the Education of Gifted Young Scientists*, *8*(4), 1493–1507. https://doi.org/10.17478/jegys.792830

Suparno, P. (2009). *Study of high school/MA physics curriculum based on KTSP*. Yogyakarta: Sanata Dharma University

Surosos, S. (2016). Analysis of student errors in doing thermodynamic physics problems in students of SMA Negeri 1 Magetan. *Journal of Mathematics and Science Education*, *4*(1), 8–18. https://doi.org/10.25273/jems.v4i1.200

Tekege, M. (2017). Utilization of Information and Communication Technology in Learning YPPGI Nabire High School. *Jurnal FATEKSA: Jurnal Teknologi dan Rekaya*, *2*(1), 40–52. https://uswim.e-journal.id/fateksa/article/view/38

Windawati, R., &; Koeswanti, H. D. (2021). Development of android-based educational games to improve student learning outcomes in elementary schools. *Basicedu Journal*, *5*(2), 1027–1038. https://doi.org/10.31004/basicedu.v5i2.835