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Developing an Augmented Reality-Assisted E-Module Based on Local Wisdom of Pedicabs for Physics Teaching

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Abstract: This study aims to reveal the feasibility of an augmented reality-assisted physics e-module based on the local wisdom of pedicabs in teaching. This study uses the 4-D development model (define, design, develop, and disseminate). The research data were obtained from the results of the product feasibility evaluation by material experts and media experts (two expert lecturers, three physics teachers, and two peer reviewers), as well as from the student response questionnaire. The result of the assessment by material and media experts shows the developed module is in the very good category. Assessment of student responses to the developed e-module on the circular motion material shows that in terms of the attractiveness aspect it is in a good category, and in terms of usability and operation aspects, it is in a good category. The developed augmented reality-assisted physics e-module based on the local wisdom of the pedicab is suitable for use in teaching circular motion materials.

Keywords: Augmented Reality; E-module; Local Wisdom; Pedicabs; Physics Teaching

Introduction

Technology in science is developing rapidly in line with human needs and demands in various fields, so every human being needs a skill. This skill is the main foundation in this aspect of life. Every human being is required to have critical thinking skills; to be able to master technology, communication, collaboration; and to connect knowledge with the real world (Anggraeni & Sole, 2018). These skills become a major component to maintain the life of the people of the 21st century (Nazifah & Asrizal., 2022). The creation of 21st-century skills requires learning as a bridge. Learning is closely related to the knowledge gained at school.

The implementation of Curriculum 2013 is adjusted to the development of students, in which independence and activeness in the learning process must be prioritized (Abtokhi et al., 2021; Wong et al., 2021). The main source of knowledge comes from teachers, and students are only provided with physics books to increase their understanding of physics concepts. Most of the students only complete calculations but are not able to evaluate and interpret the real physics concepts (Permata & Suyana, 2019; Sagala, et al., 2019), so there is an assumption that physics is difficult to understand and boring (Jufrida et al., 2019) because they consider physics as a subject to memorize formulas. Of course, this causes fear and reluctance to study physics at a higher level. Physical events can actually be described visually, but there is a need for a special method that is expected to be able to explain these events so that they can be understood (Rusli, 2018; Warti & Hurriyah, 2019). Students are required to read physics books without being equipped with supporting multimedia (Yulianci, et al., 2021). In the teaching-learning processes, the media equipped with multimedia can improve student's understanding of physics material (Hermansyah et al., 2019; Husein, et al., 2019). The learning difficulties of students can be overcome by using multimedia-assisted learning media and students who play an active role are able to provide an in-depth understanding of the concept.

Multimedia-based e-modules are better than printed modules usually used as learning resources. Electronic learning and/or learning with the help of electronic media can improve learning outcomes (Dewi, & Kuswanto, 2023). The technology prepared in the teaching process includes the Internet, the Android, and

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IOS operating systems on smartphones. In line with the time, the teaching system that was previously face-to-face becomes online teaching, digital, or online Arizona et al. (2020) and e-modules can be used anytime and anywhere without space and time limitations.

Currently, many new technologies are emerging, one of which is Augmented Reality (AR), which is undergoing significant development (Situmorang et al., 2021). Augmented reality is a technology that can develop and contribute to higher-order thinking skills. It makes objects become virtual three-dimensional and look real. It is a technology that utilizes mobile phones and allows students to interact with digital information (Elfeky & Elbyaly, 2021; Suryanto et al., 2022; Wibowo, 2023). Augmented reality technology makes a positive contribution by attracting the attention and interest of students in learning abstract concepts because it creates a unique and realistic learning experience so that it can increase student activity and achievement (Sirakaya & Cakmak, 2018).

Indonesia is famous for its local wisdom so it needs to be integrated into the teaching-learning process. Learning activities that are associated with local wisdom can motivate students to learn more (Liliarti & Kuswanto, 2018; Wati et al., 2018). Nowadays, educators pay little attention to existing local wisdom and are not very creative with learning methods, and this is a factor in not teaching local knowledge around them (Demssie et al., 2020; Rahayu & Kuswanto, 2021), and this causes teaching without reviewing the potential for existing diversity, background, and uniqueness of an area (Wati et al., 2021). About 80% of the sample have recognized local/indigenous wisdom in their respective school environment. However, none of them has the capacity to apply the indigenous to the science curriculum (Kurniawan & Kuswanto, 2021; Winarto et al., 2022). Therefore, introducing local wisdom to children through local transportation into education is one of the efforts to preserve local transportation, one of which is the pedicab.

The augmented reality-assisted e-module based on the local wisdom of the pedicab which was developed was combined with circular motion physics material and was tested for its feasibility by media and material experts as well as through student responses to the e-module. The developed media can be operated on Android smartphones and is considered effective and efficient because it can be operated anytime and anywhere.

Method

This development research uses the 4D model (define, design, develop, and disseminate), (1) defining and determining various needs in the teaching process and the stage at which was carried out the collection of the data related to developed product in the form of an augmented reality-assisted physics e-module based on the local wisdom of the pedicab; (2) designing devices and media for an augmented reality-assisted physics e-module based on the local wisdom of the pedicab; (3) developing and constructing instruments that pay attention to several aspects of the assessment aspects of electronic modules. The instruments that have been compiled then enter the validation stage to assess the electronic media of the module as valid; (4) disseminate is introducing the product widely carried out by giving it to teachers and students in schools in limited quantities as a medium that can be used in physics teaching and learning, introduced in the form of thesis documents, and making scientific articles to be published through international seminars and journals. The stage of this research is shown in Figure 1.

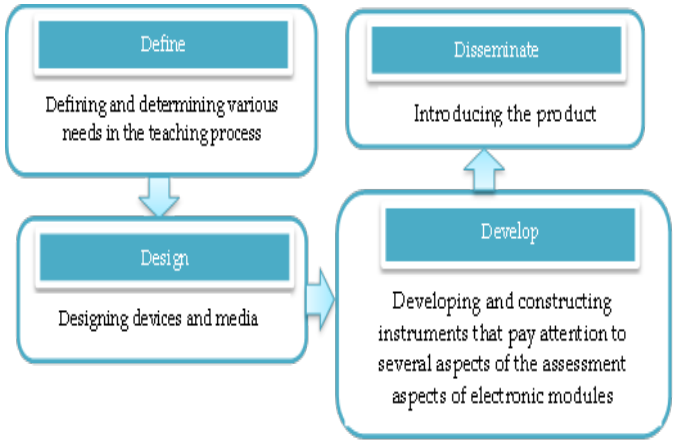

Figure 1. 4D Models in the Research Stage

The research data were collected through observation, interviews, and documentation, as well as by using a questionnaire. The feasibility of the developed e-module, lesson plans, and test instruments was assessed using a questionnaire that was validated by two lecturers as materials and media experts, three physics teachers, and two peer reviewers. The questionnaire was also given to students to assess and measure the feasibility of the media.

The technique of the analysis of the research instruments and products, such as the feasibility of lesson plans, the product in the form of an e-module media, and student response questionnaire is by looking at the scores on the scoring sheet. Each question used a score with a range of 1-4. Then the average ideal score (Xi) and standard deviation were calculated using the following formula (SBi). Furthermore, the scores were classified into groups of feasibility levels of the product to be developed, as shown in Table 1 (Fitriadi et al., 2022; Kholis et al., 2020).

Table 1. Scoring Criteria

Score Range	Category
X > Mi + 1.8SBi	Very Good
Mi + 0.6SBi < X ≤ Mi + 1.8SBi	Good
Mi -1.8SBi < X ≤ Mi – 0.6SBi	Fair
X ≤ Mi – 1.8SBi	Poor

Result and Discussion

Developing the augmented reality-assisted physics e-module teaching media based on the local wisdom of pedicabs refers to the 4D model with the first step being defining. Based on the results of observations and interviews, teaching and learning in schools used printed books and, during the COVID-19 pandemic, schools used online learning systems and are transitioning to hybrid learning through the WhatsApp group platform, Google Classroom, and Edmodo. Based on the platform used in schools, the teaching and learning of physics were not very attractive to students and the learning process was not very optimal. The selection of circular motion material was chosen as the material to be explored in the augmented reality-assisted physics e-module based on the local wisdom of the pedicab. The traditional pedicab is inherent in the life of the Indonesian people and especially the people of the island of Java, so it can be integrated into the concept of the circular motion chapter.

The next step was the step of designing. In the teaching process, a teaching implementation plan and media are needed. The physics e-module contains material descriptions and practice questions that can be accessed anytime and anywhere in an application on a smartphone that is used to convey information and physics content. The local wisdom of the pedicab helps preserve the culture of the archipelago and connects the concepts of physics that exist in the environment and the surrounding culture. The augmented reality which is integrated into the e-module helps students in analyzing physics concepts with the local wisdom of pedicabs on circular motion material through 3D animation. The initial design was carried out by making the e-module layout in the form of an application on a smartphone on the AdobeXD application, as shown in Figure 2.

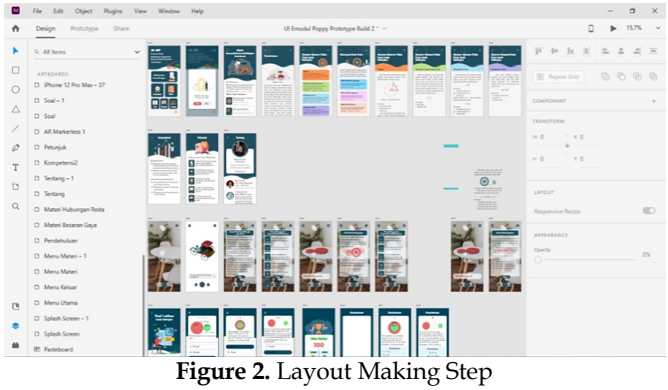

Figure 2. Layout Making Step

The design of the making of 3D pedicab animation objects and augmented reality applications used the Rhinoceros3D and Unity3D applications, as shown in Figure 3 and 4.

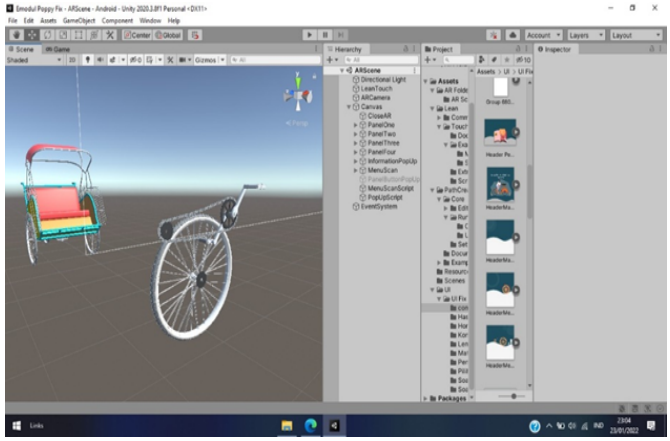

Figure 3. Design of 3D Pedicab Object in Augmented Reality

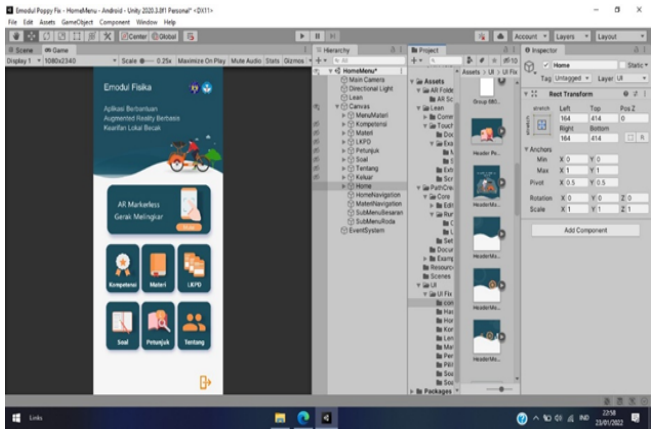

Figure 4. Augmented Reality Application Menu

The 3D animated objects were made with markerless properties that could appear on the camera without a marker image. The arrangement of the augmented reality application was concatenated into one with the e-module layout arrangement so that in the e-module menu there was an augmented reality camera menu option. The final result is an APK format application that can be installed on smartphone devices.

The augmented reality-assisted physics e-module based on the local wisdom of the pedicab is designed in such a way that it can be used correctly by students. The application cover clearly displays writing and images that represent the media (augmented reality-assisted e-module based on the local wisdom of the pedicab and learning materials), and there are instructions for using the e-module and instructions when opening the AR camera menu, which aim to make it easier for users to know how to use the application correctly, as shown in Figure 5.

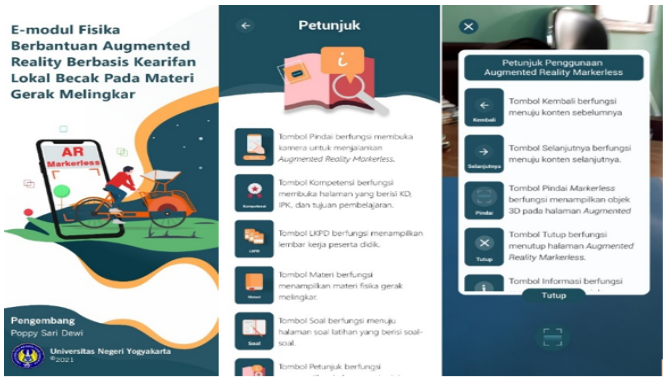

Figure 5. Cover and User Manual

The material features a circular motion chapter via a traditional pedicab, which is explained by a markerless augmented reality camera. The augmented reality camera aims to display the 3D objects that are markerless or without the help of a detecting image, as shown in Figure 6.

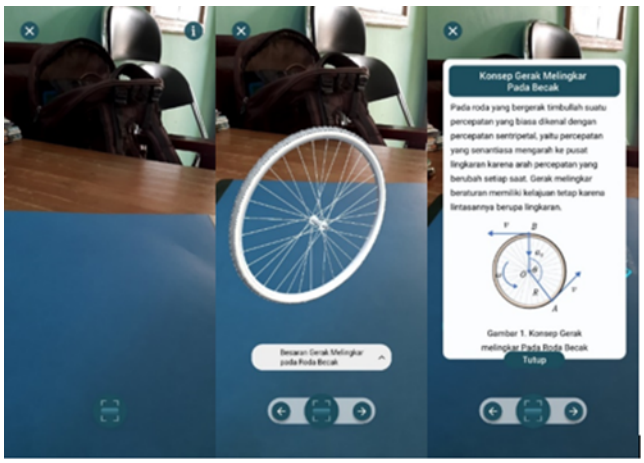

Figure 6. Augmented Reality Markerless Camera

The e-module contains worksheets, practice questions, and a discussion of practice questions along with the final score that will be obtained by students. This aims to train students' thinking skills when they are studying circular motion material, as shown in Figure 7.

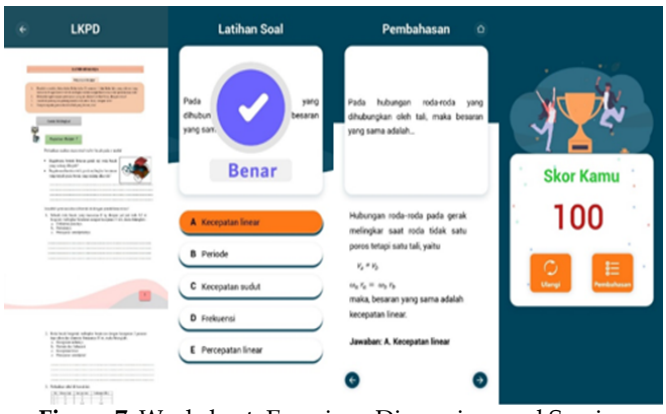

Figure 7. Worksheet, Exercises, Discussion, and Scoring

At the development stage, the lesson plans were made using the revised Curriculum 2013. The lesson plans were made for three meetings talking about the circular motion chapter for the hybrid learning class. The augmented reality-assisted e-module based on the local wisdom of pedicabs passed through expert appraisal and developmental testing when it was developed. The expert appraisal stage was the assessment stage by media and material experts. The developmental testing stage was carried out on a limited test to obtain responses from students using an assessment sheet. Assessments by media experts, material experts, and students were used to improve the quality of learning media to be better and be able to be used in broad tests.

The result of the assessment of the developed lesson plans and e-modules on circular motion material, which was carried out by two lecturers, three teachers, and two colleagues, whose results could be used in learning with improvements in advance to improve product quality, can be seen in Tables 2, 3, and 4.

Table 2. Result of Lesson Plan Validation

Aspects	Indicators	Total	Mean	Category
Identity	1.00	28.00	4.00	Very Good
Teaching Objectives	1.00	26.00	3.70	Very Good
Content	5.00	135.00	19.30	Very Good

Based on the result of the analysis of the data obtained, it can be concluded that the lesson plans are in a very good category. This illustrates that lesson plans can be used.

Table 3. Result of Media Validation

Aspects	Indicators	Total	Mean Score	Category
Content Quality	3.00	81.00	11.57	Very Good
Language	3.00	82.00	11.71	Very Good
Feasibility	3.00	78.00	11.14	Very Good
Design	2.00	55.00	7.86	Very Good
Visual Display	3.00	79.00	11.29	Very Good

Based on the result of the analysis of the data obtained, it can be concluded that the media is in a very good category, with several improvements. This illustrates that the media can be used.

Table 4. Result of Material Validation

Aspects	Indicators	Total	Mean Score	Category
Teaching	3.00	81.00	11.57	Very Good
Content	3.00	84.00	12.00	Very Good
Adequacy Materials	3.00	84.00	12.00	Very Good

The materials assessment aimed to determine the feasibility of the material or physics concept in the e-module. Based on the result of the e-module analysis obtained from media and material validation, it can be concluded that the result of the materials assessment is in a very good category, which is in line with the research by Nugraheni & Mundilarto (2022) Wati et al. (2021), so that it can be used in learning.

The e-module that had been validated got a product quality score. Then it was improved in accordance with the validator's suggestions, comments, and responses. The product trial was conducted on 36 grade XI students of SMAN 6 Yogyakarta and the result of student assessments is presented in Table 5.

Table 5. Result of Student Response Evaluation

Aspects	Reviewer Mean Score	Category
Attractiveness	17.10	Very Good
Usefulness	23.00	Good
Operation	13.30	Good

The results of the analysis show that the attractiveness, usability, and operation of the augmented reality-assisted physics e-module based on the local wisdom of the pedicab is averagely in a good category. This shows that the developed e-module can be used in teaching.

At the distribution phase, the augmented reality-assisted physics e-module based on the local wisdom of the pedicab on circular motion material was disseminated to grade X science students of SMAN 1 Depok, Sleman in the 2021/2022 academic year and to physics teachers of class X as a medium that could be used in the teaching and learning of physics. Further dissemination was through the publication stage in the form of scientific articles.

The result of the study shows the developed augmented reality-assisted physics e-module based on the local wisdom is suitable for use in physics teaching and learning. This is in line with several previous studies conducted by (Hurrahman et al., 2022; Yulkifli et al., 2022). The developed augmented reality-assisted physics e-module based on the local wisdom is feasible to be used as a complement to learning for students, and it can be used anywhere and anytime.

Conclusion

Based on the result of the evaluation of the developed e-module by materials and media experts, the developed augmented reality-assisted physics e-module is in a very good category. According to student responses to the developed e-module, in the attractiveness aspect, it is in a good category, and in the usability and operation aspects, it is also in a good category. Therefore, it can be concluded that the developed augmented reality-assisted physics e-module based on the local wisdom of the pedicab is suitable for use in the teaching and learning of circular motion materials.

References

Abtokhi, A., Jatmiko, B., & Wasis, W. (2021). Evaluation of self-regulated learning on problem-solving skills in online basic physics learning during the COVID-19 pandemic. *Journal of Technology and Science Education,* 11(2), 541-555. https://doi.org/10.3926/jotse.1205

Anggraeni, D. M., & Sole, F. B. (2018). E-Learning Moodle, Media Pembelajaran Fisika Abad 21. *Jurnal Penelitian Dan Pengkajian Ilmu Pendidikan: E-Saintika*, *1*(2), 57. https://doi.org/10.36312/e-saintika.v1i2.101

Arizona, K., Abidin, Z., & Rumansyah, R. (2020). Pembelajaran Online Berbasis Proyek Salah Satu Solusi Kegiatan Belajar Mengajar Di Tengah Pandemi Covid-19. *Jurnal Ilmiah Profesi Pendidikan*, 5(1), 64–70. https://doi.org/10.29303/jipp.v5i1.111

Demssie, Y. N., Biemans, H. J. A., Wesselink, R., & Mulder, M. (2020). Combining indigenous knowledge and modern education to foster sustainability competencies: Towards a set of learning design principles. *Sustainability, 12(*17), 6823. https://doi.org/10.3390/SU12176823

Dewi, P.S., & Kuswanto, H. (2023). The effectiveness of the use of augmented reality-assisted physics e-module based on pedicab to improve mathematical communication and critical thinking abilities. *Journal of Technology and Science Education, 13*(1), 53-64. https://doi.org/10.3926/jotse.1714

Elfeky, A. I. M., & Elbyaly, M. Y. H. (2021). Developing skills of fashion design by augmented reality technology in higher education. *Interactive Learning Environments, 29*(1), 17–32. https://doi.org/10.1080/10494820.2018.1558259

Fitriadi, P., Latumakulita, I. I., Jumadi, J., & Warsono, W. (2022). CTL-Based Physics E-Book to Improve Students Physics Problem Solving Skills in Senior Highschool. *Jurnal Penelitian Pendidikan IPA, 8*(3), 1121–1127. https://doi.org/10.29303/jppipa.v8i3.1341

Hermansyah, H., Gunawan, G., Harjono, A., & Adawiyah, R. (2019). Guided inquiry model with virtual labs to improve students'understanding on heat concept. *Journal of Physics: Conference Series, 1153*(1). https://doi.org/10.1088/1742-6596/1153/1/012116

Hurrahman, M., Erlina, E., Melati, H. A., Enawaty, E., & Sartika, R. P. (2022). Pengembangan E-Modul Berbasis Multipel Representasi Dengan Bantuan Teknologi Augmented Reality untuk Pembelajaran

Materi Bentuk Molekul. *Jurnal Pendidikan Sains Indonesia, 10*(1), 89–114. https://doi.org/10.24815/jpsi.v10i1.22579

Husein, S., Gunawan, Harjono, A., & Wahyuni, S. (2019). Problem-Based Learning with Interactive Multimedia to Improve Students' Understanding of Thermodynamic Concepts. *Journal of Physics: Conference Series, 1233*(1). https://doi.org/10.1088/1742-6596/1233/1/012028

Jufrida, J., Kurniawan, W., Astalini, A., Darmaji, D., Kurniawan, D. A., & Maya, W. A. (2019). Students' attitude and motivation in mathematical physics. *International Journal of Evaluation and Research in Education, 8*(3), 401–408. https://doi.org/10.11591/ijere.v8i3.20253

Kholis, N., Kartowagiran, B., & Mardapi, D. (2020). Development and Validation of an Instrument to Measure a Performance of Vocational High School. *European Journal of Educational Research, 9*(3), 955-966. https://doi.org/10.12973/eu-jer.9.3.955

Kurniawan, H. D., & Kuswanto, H. (2021). Improving Students' Mathematical Representation and Critical Thinking Abilities Using the CAKA Media Based on Local Wisdom. *International Journal of Interactive Mobile Technologies, 15*(2), 72–87. https://doi.org/10.3991/ijim.v15i02.11355

Liliarti, N., & Kuswanto, H. (2018). Improving the Competence of Diagrammatic and Argumentative Representation in Physics through Android-based Mobile Learning Application. *International Journal of Instruction, 11*(3), 106–122. https://doi.org/10.12973/iji.2018.1138a

Nazifah, N., & Asrizal, A. (2022). Development of STEM Integrated Physics E-Modules to Improve 21st Century Skills of Students. *Jurnal Penelitian Pendidikan IPA*, *8*(4), 1783–1789. https://doi.org/10.29303/jppipa.v8i4.1820

Nugraheni, V. Y. S. T., & Mundilarto, M. (2022). Development of 2-D augmented reality integrated physics e-book to improve students' problem-solving skills. *Momentum: Physics Education Journal, 6*(2), 171-180. https://doi.org/10.21067/mpej.v6i2.6623

Permata, A. R., Muslim, M., & Suyana, I. (2019). Analisis Kemampuan Berpikir Kritis Siswa SMA Pada Materi Momentum Dan Impuls. *Prosiding Seminar Nasional Fisika, 8*, 1-8. https://doi.org/10.21009/03.snf2019.01.pe.02

Rahayu, M. S. I., & Kuswanto, H. (2021). The effectiveness of the use of the android-based carom games comic integrated to discovery learning in improving critical thinking and mathematical representation abilities. *Journal of Technology and Science Education, 11*(2), 270–283. https://doi.org/10.3926/JOTSE.1151

Rusli, M. R. (2018). Pengembangan LKPD Pembelajaran Fisika Berorientasi Penguatan Karakter Kerjasama Peserta Didik di SMAN 1 Tanete Rilau. *Prosiding Seminar Nasional Fisika PPs Universitas Negeri Makassar*, 1–4. Retrieved from https://ojs.unm.ac.id/semnasfisika/article/view/8691

Sagala, R., Umam, R., Thahir, A., Saregar, A., & Wardani, I. (2019). The effectiveness of stem-based on gender differences: The impact of physics concept understanding. *European Journal of Educational Research, 8*(3), 753–761. https://doi.org/10.12973/eu-jer.8.3.753

Sirakaya, M., & Cakmak, E. K. (2018). The effect of augmented reality use on achievement, misconception and course engagement. *Contemporary Educational Technology, 9*(3), 297–314. https://doi.org/10.30935/cet.444119

Situmorang, R., Kustandi, C., Maudiarti, S., Widyaningrum, R., & Ariani, D. (2021). Entrepreneurship Education Through Mobile Augmented Reality for Introducing SMEs in Higher Education. *International Journal of Interactive Mobile Technologies, 15*(3), 17–29. https://doi.org/10.3991/ijim.v15i03.18437

Suryanto, R. A., Dewi, P. S., & Rosana, D. (2022). Development of augmented reality integrated physics e-worksheet to improve students' problem-solving skills. *Momentum: Physics Education Journal, 6*(2), 150-161. https://doi.org/10.21067/mpej.v6i2.6624

Warti, Y., & Hurriyah. (2019). Pengembangan LKPD Berbasis Problem Based Learning pada Materi Gelombang Elektromagnetik Untuk Peserta Didik Kelas X SMA/MA. *Natural Science Journa, 5*(1), 766–774. http://doi.org/10.15548/nsc.v5i1.898

Wati, M., Hartini, S., Hikmah, N., & Mahtari, S. (2018). Developing physics learning media using 3D cartoon. *Journal of Physics: Conference Series, 997*(1). https://doi.org/10.1088/1742-6596/997/1/012044

Wati, M., Apriani, R., Miriam, S., & Mahtari, S. (2021). Pengembangan E-Modul Suhu Dan Kalor Bermuatan Kearifan Lokal Melalui Aplikasi Sigil. *Jurnal Inovasi dan Pembelajaran Fisika, 8*(1), 112–121. https://doi.org/10.36706/jipf.v8i1.11107

Wibowo, F.C. (2023). Effects of Augmented Reality Integration (ARI) based Model Physics Independent Learning (MPIL) for facilitating 21st-Century Skills (21-CS). *Journal of Technology and Science Education,* 13(1), 178-192. https://doi.org/10.3926/jotse.1800

Winarto, W., Cahyono, E., Sumarni, W., Sulhadi, S., Wa hyuni, S., & Sarwi, S. (2022). Science teaching approach Ethno-SETSaR to improve pre-service teachers' creative thinking and problem solving

skills. *Journal of Technology and Science Education, 12*(2), 327-344. https://doi.org/10.3926/jotse.1367

Wong, J., Baars, M., de Koning, B.B., & Paas, F. (2021). Examining the use of prompts to facilitate self-regulated learning in Massive Open Online Courses. *Computers in Human Behavior, 115*, 106596. https://doi.org/10.1016/j.chb.2020.106596

Yulianci, S., Nurjumiati, N., asriyadin, A., & Adiansha, A. A. (2021). The Effect of Interactive Multimedia and Learning Styles on Students' Physics Creative Thinking Skills. *Jurnal Penelitian Pendidikan IPA*, *7*(1), 87–91. https://doi.org/10.29303/jppipa.v7i1.529

Yulkifli, Y., Yohandri, Y., & Azis, H. (2022). Development of physics e-module based on integrated project-based learning model with Ethno-STEM approach on smartphones for senior high school students. *Momentum: Physics Education Journal, 6*(1), 93–103. https://doi.org/10.21067/mpej.v6i1.6316