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The Application of Mixed Reality Technology in The 5.0 Era Learning Pencak Silat to Support The Independent Curriculum

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Abstract
Pencak silat, as a cultural heritage and traditional sport of Indonesia, holds high cultural, spiritual, and physical skill values. One of the promising technologies in the 5.0 era to be applied in supporting the Independent Curriculum is Mixed Reality (MR). This research aims to develop and test the application of MR technology in the learning of pencak silat to support the Independent Curriculum in the 5.0 era. Using the Research and Development (R&D) method, this study goes through several stages, including needs analysis, product development, product design, development, implementation, and finally evaluation. The developed MR application allows students to learn the movements of pencak silat virtually in an interactive environment. The research results indicate a significant improvement in students' abilities. The average pretest score of 60.35 increased to 85.45 on the posttest after the use of the MR application, demonstrating an enhancement in students' understanding and skills. In addition, the results of the validation tests by material and media experts are both in the "Very Good" category, indicating that this MR application is suitable for use in learning. This technology also supports more flexible learning in accordance with the principles of the Independent Curriculum, which emphasizes differentiated learning, although there are challenges regarding infrastructure readiness and teacher training.

Keywords: Differentiation; Independent Curriculum; Mixed Reality; Pencak Silat

1. Introduction

The Independent Curriculum is an education policy in Indonesia that provides flexibility to teachers and students in the learning process (Aprianti & Maulia, 2023). This curriculum focuses on project-based learning, the development of 21st-century skills, and the mastery of essential competencies such as literacy and numeracy (Kahar et al., 2021). The independent curriculum provides students with the freedom to learn according to their interests, talents, and needs, while teachers act as facilitators. This approach allows for education that is more relevant and suited to the students' circumstances, and encourages more independent and meaningful learning (Wang et al., 2024). In addition, the assessment in the Independent Curriculum is broader and relies on various types of evaluations, such as projects and practical activities, rather than just exam results.

Differentiated learning is the primary way to meet the diverse learning needs in every classroom within the independent curriculum (Tarekegn & Mihiretie, 2024). This learning focuses on adjusting content, processes, and learning products based on students' interests, readiness levels, and learning styles (Deunk et al., 2018). With differentiated learning, each student can learn according to their individual potential (Hussein et al., 2024). If each student receives a learning experience that matches their pace

and abilities, teachers adjust the curriculum, delivery methods, and assessment techniques (Jufri et al., 2023). This strategy creates an inclusive learning environment where every student has the opportunity to succeed in the way that suits them best. Differentiated learning consists of four main components: content, process, product, and learning environment. They are tailored to the needs and characteristics of the students (Nugroho & Darmawan, 2024). First, differentiate the content related to the material being taught to students. Teachers can adjust the difficulty level of the material according to the abilities and understanding of the students (Wahyuni, 2022). More advanced students, for example, can be given more complex material, while students who need additional support can be provided with more basic material. Both differentiation processes focus more on the methods of learning and delivery (Langelaan et al., 2024). Each student learns in a different way: visually, auditorily, or kinesthetically (Sutrisno, 2023). To address this issue, teachers must change their learning approach by implementing interactive presentations, videos, or practical activities that allow students to learn ideas in a way that suits their own styles. This also includes variations in activities such as group work, discussions, or hands-on experiments (Suroto et al., 2024). The third is product differentiation, or learning outcomes, which is the final component. The final assignments given to students in differentiated learning can vary depending on their interests and abilities (Naibaho, 2023). To demonstrate their understanding of the studied topic, students can choose to create a written report, a multimedia presentation, or a visual project such as a poster. Differentiated learning ensures that each student can convey information in the way that suits them best (Gusteti & Neviyarni, 2022). There are four differentiated learning environments, and there are two types of learning environments where students can learn: those that can enhance their learning outcomes and those that can hinder them. A calm and conducive learning environment can improve students' learning outcomes, while a noisy learning environment can reduce students' concentration and diminish their understanding of the subject matter (Anggraeni et al., 2024).

The learning of pencak silat is the process of acquiring skills in the traditional Indonesian martial art (Nurkholis & Weda, 2015). Pencak silat has cultural and philosophical values beyond just being a physical sport. These values encompass social, mental, and spiritual aspects. Students are taught basic movements such as stances, steps, attacks, and blocks (Wiguno et al., 2024). Then, according to their skills, more complex movements are taught. Pencak silat is a complex physical sport aimed at enhancing strength, agility, balance, and body coordination (Syaifullah & Maghribi, 2023). In addition, pencak silat teaches values such as self-control, discipline, cooperation, and respect for opponents. Students also learn about the ethics of pencak silat, including how this martial art is used to protect oneself without harming others (Yuliana & Wahyudi, 2022). The learning of pencak silat is typically conducted through live demonstrations and repetitive practice. This is done to enhance students' muscle memory and reflex abilities in various situations.

In the 5.0 era, education faces the challenge of adapting to the developments of globalization and advancements in information technology (Legi et al., 2023). As an important component of the school curriculum, physical education must be adapted to technological advancements to be engaging and assist students in learning (Allsabah et al., 2022). Pencak silat, as a traditional Indonesian martial art, possesses rich cultural, spiritual, and physical skill values (Karo-Karo et al., 2023), has great potential to be taught if creative methods using the latest technology are applied. In the 5.0 era, human-technology collaboration is crucial for various aspects of life, such as education (Cojocaru et al., 2022). Learning pencak silat in the 5.0 era uses Mixed Reality (MR) technology to make the learning process more interactive and engaging.

MR technology can assist differentiated learning by combining elements of the real and virtual worlds to make learning more interactive and unique (Eikeland & Ohna, 2022). MR should assist teachers in adjusting the material provided to students according to their abilities and interests in the context of differentiated learning (Santoso et al., 2022). For example, more skilled students can access more complex MR simulations or scenarios, while students who need more support can start with simpler

and more visual materials. MR technology combines the real world with the virtual, allowing users to interact with virtual objects in the real world (Rosi et al., 2019). By providing students the opportunity to learn in a realistic simulated environment, this opens up new possibilities in education. Moreover, it allows students to stay connected with the real world (Maas & Hughes, 2020). Therefore, MR not only expands the boundaries of conventional learning but also enhances student participation, motivation, and understanding of concepts through comprehensive and multidimensional learning experiences.

2. Method

This research uses research and development (R&D) methods, and it develops Mixed Reality (MR) technology to teach pencak silat to high school students in Bojonegoro. The stages of this research include needs analysis, product development, product design, development, implementation, and finally evaluation (Setyosari, 2016). The main focus of this research is on the use of open-source tools such as Unity 7, which serves as the primary framework for the development of MR applications (Zakharov et al., 2020). Figure 1 shows the flowchart of the developed application process. The first process begins with selecting a marker model. Marker models are divided into two categories of tracking: object tracking and image tracking. After selecting the marker, the image is rendered or combined with the environment, which is then integrated into mixed reality. The final process is displaying the image in a 3D object. The following are the modified research steps :

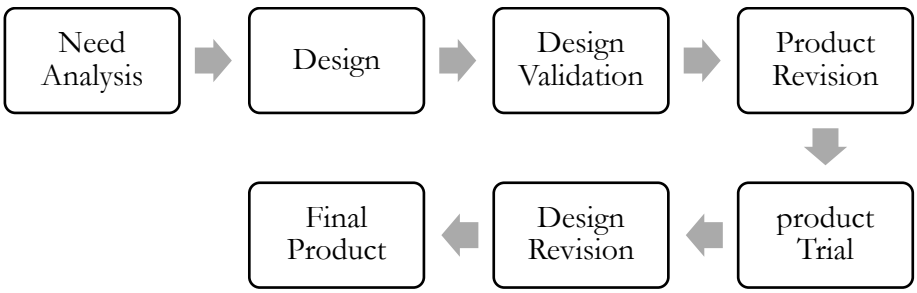

Figure 1. Research Steps

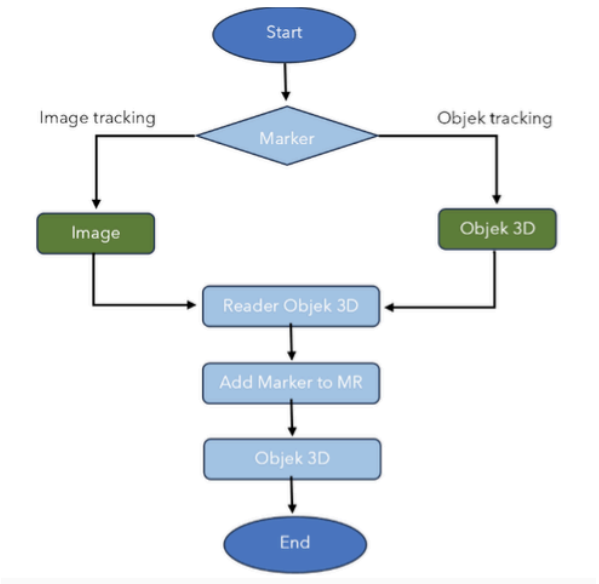

Figure 2. Flowchart of Mixed Reality Product Development

This research begins the product design phase by analyzing the issues in learning pencak silat. This analysis covers the needs of students and teachers, as well as how MR technology can assist learning in accordance with the independent curriculum. Based on the results of this analysis, a learning module that integrates MR technology will be designed, which includes the development of materials and learning scenarios. After the design is complete, the product development stage begins (Knierim et al., 2018). Here, interactive learning content is created using MR technology. Students can practice pencak silat virtually with this application. The product that has been developed is then validated by experts, such as material experts and media experts. To ensure that the product meets the desired standards, revisions are made based on feedback from experts before testing (Fatirul & Walujo, 2022).

The product trial involved 32 students from SMAN MT Bojonegoro. The purpose of this trial is to identify product shortcomings and gather initial feedback from students and teachers. Data was collected through observation, questionnaires, and skill tests (Arifin, 2018). After limited testing, the findings are used to modify the product; user input and trial results improve the product. This process ensures that the product is ready for public use. In this study, the validity of the instrument was assessed by three media experts and three content experts who evaluated the quality of the product using a Likert scale from 1 to 5; the lowest rating is 1 and the highest rating is 5. The Aiken Index was used to calculate the validity of the instrument by considering the number of experts, the scale range, and the scores given (Nabil et al., 2022). The following formula is used to calculate the Aiken index :

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

Description:

- s : The score given by the expert
- $\int$: Lowest score on the scale
- c : The number of categories on the scale
- n : Number of experts

3. Result

This research develops a mixed reality-based learning product to support the learning of pencak silat in the Independent Curriculum. Mixed reality technology allows users to interact simultaneously with the digital and physical worlds, making learning more enjoyable. By using animated movements of pencak silat combined with Augmented Reality (AR) and Virtual Reality (VR) technology, this product provides students with the opportunity to learn pencak silat techniques in a more visual and practical way. The learning materials are organized according to the flow of the movements in pencak silat, making the presentation orderly and easy for students to understand. This product not only helps students understand the material, but also provides a fun and productive learning experience.

The validity of the instrument was obtained through assessments from six experts, which were analyzed using the Aiken index formula. The evaluation of the developed product was conducted using a Likert scale model, ranging from 1 to 5, where each scale is interpreted sequentially as very good, good, fair, poor, and very poor. Based on the validation conducted by six experts, consisting of three subject matter experts and three media experts, the results indicate that the MR instrument has been well designed and developed, with a validity score of 0.95 for subject matter experts and 0.93 for media experts. A recap of the overall validity assessment results from the five experts is presented in Table 1.

Table 1. Recapitulation of expert validation using the aiken index

Aspects Being Evaluated	Aiken Indeks	Validation
Material Suitability	0.95	Very Good
Media Suitability	0.93	Very Good

The characters are tailored to the MR model created, and the appearance of the characters is chosen to have the ability to move. This allows them to develop more diverse movements that are adapted to the movements of pencak silat. The attributes of the characters are adjusted to the clothing and attributes used according to the rules of pencak silat.

Figure 3. Character Design of Pencak Silat

Figure 4. The Process of Designing Animation for Pencak Silat

At this stage, the learning content of pencak silat will be developed in the form of interactive multimedia integrated with MR technology. The MR application will be programmed so that students can practice pencak silat virtually with the help of this technology. The next process is the validation by experts in the field from various backgrounds relevant to the content and technology of pencak silat learning. The evaluations from these three experts provide an in-depth overview that ensures the developed multimedia product for pencak silat meets the standards of content, technology, and pedagogy.

Table 2. Results of the expert material assessment

Assessment Criteria	Expert 1	Expert 2	Expert 3	Means	Description
Learning Criteria					
1. Alignment with learning objectives	4.8	4.6	4.7	4.7	Very Good
2. Ease of use for students	4.7	4.8	4.6	4.7	Very Good
3. Relevance to the Independent Curriculum	5.0	4.9	4.8	4.9	Very Good
4. Encouragement of student interaction	4.5	4.6	4.7	4.6	Very Good
Average Learning Criteria	4.75	4.73	4.7	4.73	Very Good
Content Criteria					
1. Suitability of pencak silat material	4.9	4.7	4.8	4.8	Very Good
2. Accuracy of content	5.0	4.8	4.9	4.9	Very Good
3. Integration of content with technology	4.8	4.9	4.7	4.8	Very Good
4. Depth and breadth of material	4.6	4.7	4.5	4.6	Very Good
Average Content Criteria	4.83	4.78	4.73	4.78	Very Good
Total Overall Average	4.79	4.76	4.72	4.76	Very Good

After the assessment by the content experts is completed, the evaluation continues with the assessment by media experts. These three media experts have strong experience in the design and development of digital learning media, and they play a crucial role in evaluating the technical and aesthetic aspects of the product to ensure that the developed learning media is of high quality and effective in assisting students' learning.

Table 3. Results of the media expert assessment

Assessment Criteria	Expert 1	Expert 2	Expert 3	Means	Description
Appearance					
1. Attractive interface design	4.7	4.8	4.6	4.7	Very Good
2. Visual alignment with the material	4.8	4.9	4.7	4.8	Very Good
3. Consistency in color, font, and icons	4.6	4.7	4.6	4.63	Very Good
4. Good and tidy layout arrangement	4.7	4.8	4.8	4.77	Very Good
Average Appearance	4.7	4.8	4.68	4.73	Very Good
Programming					
1. Speed of access and application response	4.5	4.6	4.7	4.6	Very Good
2. Application stability	4.8	4.7	4.7	4.73	Very Good
3. Ease of navigation and interaction	4.6	4.8	4.7	4.7	Very Good
4. Compatibility with various devices	4.7	4.6	4.5	4.6	Very Good
Average Programming	4.65	4.68	4.65	4.66	Very Good
Overall Average Total	4.68	4.74	4.67	4.7	Very Good

After the formative evaluation, the summative evaluation is conducted. The purpose of the summative evaluation is to test potential users for MR-based multimedia products. The trial consists of three phases: one-to-one testing, Material, Pedagogical, and Motivation and Readability. Table 4 presents a summary of the test results from these three stages, and Figure 4 displays a bar chart that illustrates the comparison results of each type of test, highlighting the effectiveness and readiness of the product for widespread use in learning.

Table 4. Product test results

Assessment Criteria	One to one	Small groupl	Field	Mean	Categpry
Display	4.3	4.5	4.7	4.5	Very Good
Material	4.2	4.4	4.6	4.4	Very Good
Pedagogical	4.4	4.5	4.6	4.5	Very Good
Motivation and Readability	4.5	4.6	4.7	4.6	Very Good

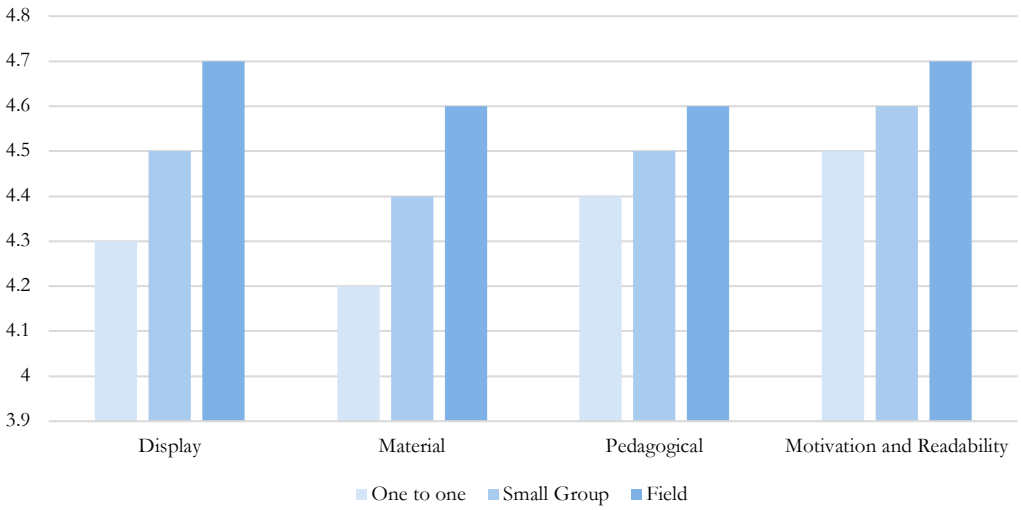

Figure 5. Product Testing Results Diagram

After the product trial was conducted, it was followed by a paired sample t-test to analyze the results. The purpose of the paired sample t-test is to measure how effective the product is in improving learning outcomes for 32 students who used the MR-based multimedia product. The statistical test results show a difference between the pretest and posttest scores.

Table 5. Results of the paired sample t-test

Test	Mean	Std. Deviation	t	df	Sig. (2-tailed)
Pretest	65.2	4.15	-30.00	31	0.000
posttest	80.5	3.85			

The table of paired sample statistics shows a comparison between the average scores of the pretest and posttest from 32 students. The average pretest score is 65.2 with a standard deviation of 4.15, indicating moderate variation in student outcomes before using the multimedia product. The average posttest score after using the product is 80.5 with a standard deviation of 3.85, indicating that the difference between the pretest and posttest results is statistically significant, meaning that the developed multimedia product is effective in improving learning outcomes.

4. Discussion

Pencak silat is a traditional martial art that originates from Indonesia and has developed in many Southeast Asian countries (Ihsan et al., 2022). Pencak silat is not only used as a method of self-defense, but also embraces moral principles such as discipline, courage, and resilience. Pencak silat also teaches cultural values and physical skills. The Independent Curriculum encourages the use of technology in education to make learning more contextual, relevant, and focused on character development, literacy, and 21st-century skills. This approach is expected to make education more contextual, relevant, and

centered on the potential and needs of students. Technology is becoming increasingly important in learning pencak silat, as students need to understand complex and detailed movements. Traditional pencak silat learning usually involves direct demonstrations of pencak silat or instructional videos (Muzakki et al., 2023). However, there are some limitations to this method, particularly regarding student interaction and understanding of specific movements (Sinulingga et al., 2024). As a result, technologies like Mixed Reality (MR) have emerged as an important innovation in the learning of pencak silat. MR combines elements of the real and virtual worlds in one interactive space, allowing students to learn martial arts movements more effectively. With MR, pencak silat movements can be visualized in three dimensions, enabling students to see and practice every angle of the movements with digital guidance.

This research found that using MR while teaching pencak silat enhances students' understanding. The higher posttest scores compared to the pretest indicate that MR technology helps students visualize and understand movements that are more difficult to grasp through conventional demonstrations. Students also feel a greater motivation to learn, which is one of the indicators of the successful use of technology in schools. The theory of technology-based learning states that interactive technology can enhance student engagement and understanding (Rahayu et al., 2024); (Permana et al., 2024); (Ambarwati et al., 2021). This finding reinforces this theory. Furthermore, the findings of this research are consistent with previous studies by (Chang et al., 2020), It was found that AR can help students learn physical education by providing them with clearer and more in-depth images of movements. The use of MR, especially in the learning of pencak silat, is a new aspect emphasized in this research. This innovation allows students to better understand movements and enables a more dynamic interaction between students and learning materials. In pencak silat, MR is very helpful in explaining movements because many actions require a deep understanding of position, balance, and body strength. Additionally, MR has the ability to facilitate more personalized learning, allowing students to learn at their own pace and rhythm.

However, this research has several limitations that need to be taken into account. Because this research was conducted on a small group of students at one school, the results may not be applicable to a larger population. A larger and more varied sample should be used to test the generalization of the findings. In addition, the use of MR technology requires advanced software and hardware that may not be available in many schools, especially in areas with technological limitations. To develop MR more broadly in Indonesian schools, the impact of this infrastructure limitation must be evaluated. Overall, this research shows that the use of Mixed Reality in learning pencak silat successfully addresses complex issues related to movement-based learning. These results also support the goals of the Independent Curriculum, which encourages the use of technology in learning. This research also reinforces existing theories on technology-based learning and opens the door for further development in the context of education.

5. Conclusion and Recommendation

This research focuses on the effects of implementing mixed reality (MR) technology in the learning of pencak silat. MR technology also enhances students' motivation to learn. The main objective of this study is to understand how the application of MR can improve students' understanding and skills in this traditional martial art. This research shows that the use of MR yields significant results. Students can learn the movements of pencak silat in an interactive and immersive way by combining elements from the digital and physical worlds. Students feel more motivated to learn when they have enjoyable and engaging learning experiences. They feel more confident to try new methods because they can see the movements and receive instant feedback provided by technology. This high motivation directly impacts learning outcomes, as students learn faster than with traditional methods. In addition, the use of MR in learning pencak silat allows for more adaptive and flexible teaching. Students do not need to rely on direct instructions limited by time and place, as they can practice anytime and anywhere.

This allows them to practice more independently, which helps them develop their best abilities. This result is expected to assist educators and practitioners in creating more creative and effective learning methods, especially for the martial art of pencak silat. Therefore, by utilizing technology, the goal of enhancing students' understanding and skills in pencak silat can be successfully achieved.

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References

Allsabah, M. A. H., Sugito., & Kurniawan, B. T. (2022). Level of physical activity , body mass index (BMI), and sleep patterns among school students. *Journal Sport Area*, *7*(1), 134–147. https://doi.org/10.25299/sportarea.2022.vol7(1).8188

Ambarwati, D., Wibowo, U. B., Arsyiadanti, H., & Susanti, S. (2021). Studi literatur: Peran inovasi pendidikan pada pembelajaran berbasis teknologi digital. *Jurnal Inovasi Teknologi Pendidikan*, *8*(2), 173–184. 10.21831/jitp.v8i2.43560

Anggraeni, R., Mega, D., Oktavianti, P., & Aliyah, R. R. (2024). *Tata Kelola Kelas : Membangun Lingkungan Belajar Yang Efektif*. *3*, 9856–9874. https://doi.org/10.30997/karimahtauhid.v3i9.14628

Anis Aprianti, & Siti Tiara Maulia. (2023). Kebijakan Pendidikan : Dampak Kebijakan Perubahan Kurikulum Pendidikan Bagi Guru Dan Peserta Didik. *Jurnal Pendidikan dan Sastra Inggris*, *3*(1), 181–190. https://doi.org/10.55606/jupensi.v3i1.1507

Arifin, M. B. U. B. (2018). Buku ajar metodologi penelitian pendidikan. *Umsida Press*, 1–143. ISBN : 978-602-5914-19-5

Ayu Sri Wahyuni. (2022). Literature Review: Pendekatan Berdiferensiasi Dalam Pembelajaran IPA. *Jurnal Pendidikan Mipa*, *12*(2), 118–126. https://doi.org/10.37630/jpm.v12i2.562

Chang, K.-E., Zhang, J., Huang, Y.-S., Liu, T.-C., & Sung, Y.-T. (2020). Applying augmented reality in physical education on motor skills learning. *Interactive Learning Environments*, *28*(6), 685–697. https://doi.org/10.1080/10494820.2019.1636073

Cojocaru, A. M., Bucea-Manea-Ţoniş, R., Jianu, A., Dumangiu, M. A., Alexandrescu, L. U., & Cojocaru, M. (2022). The role of physical education and sports in modern society supported by IoT—a student perspective. *Sustainability*, *14*(9), 5624. https://doi.org/10.3390/su14095624

Deunk, M. I., Smale-Jacobse, A. E., de Boer, H., Doolaard, S., & Bosker, R. J. (2018). Effective differentiation Practices:A systematic review and meta-analysis of studies on the cognitive effects of differentiation practices in primary education. *Educational Research Review*, *24*, 31–54. https://doi.org/https://doi.org/10.1016/j.edurev.2018.02.002

Eikeland, I., & Ohna, S. E. (2022). Differentiation in education: a configurative review. *Nordic Journal of Studies in Educational Policy*, *8*(3), 157–170. https://doi.org/10.1080/20020317.2022.2039351

Fatirul, A. N., & Walujo, D. A. (2022). *Metode Penelitian Pengembangan Bidang Pembelajaran*. Pascal Books. ISBN : 978-623-5312-32-3

Gusteti, M. U., & Neviyarni, N. (2022). Pembelajaran berdiferensiasi pada pembelajaran matematika di kurikulum merdeka. *Jurnal Lebesgue: Jurnal Ilmiah Pendidikan Matematika, Matematika Dan Statistika*, *3*(3), 636–646. https://doi.org/10.46306/lb.v3i3.180

Hussein, A., Abdzid Ashoor, I., & Saeed Majed, S. (2024). The Effectiveness of a Differentiated Learning Strategy using Flexible Groups to Improve Football Skills and Keep It. International Journal of Disabilities Sports and Health Sciences, 7(1), 236-244. https://doi.org/10.33438/ijdshs.1370182

Ihsan, N., Hanafi, R., Sepriadi, S., Okilanda, A., Suwirman, S., & Mario, D. T. (2022). The Effect of Limb Muscle Explosive Power, Flexibility, and Achievement Motivation on Sickle Kick Performance in Pencak Silat Learning. *Physical Education Theory and Methodology*, *22*(3), 393–400. https://doi.org/10.17309/tmfv.2022.3.14

Jufri, A. P., Asri, W. K., Mannahali, M., & Vidya, A. (2023). *Strategi Pembelajaran: Menggali Potensi Belajar Melalui Model, Pendekatan, dan Metode yang Efektif*. Ananta Vidya. ISBN : 978-623-8297-50-4

Kahar, M. I., Cika, H., Nur Afni, & Nur Eka Wahyuningsih. (2021). Pendidikan Era Revolusi Industri 4.0 Menuju Era Society 5.0 Di Masa Pandemi Covid 19. *Moderasi: Jurnal Studi Ilmu Pengetahuan Sosial*, *2*(1), 58–78. https://doi.org/10.24239/moderasi.vol2.iss1.40

Karo-Karo, A. A. P., Rahayu, T., Setyawati, H., Mukarromah, S. B., & Syaifullah, R. (2023). Analysis of Pencak Silat Techniques Using a Biomechanical Approach: Systematic Literature Review. *Physical Education Theory and Methodology*, *23*(6), 947–953. https://doi.org/10.17309/tmfv.2023.6.18

Knierim, P., Kosch, T., Hoppe, M., & Schmidt, A. (2018). Challenges and opportunities of mixed reality systems in education. *Mensch und Computer 2018-Workshopband*, 10–18420. 10.18420/muc2018-ws07-0471

Langelaan, B. N., Gaikhorst, L., Smets, W., & Oostdam, R. J. (2024). Differentiating instruction: Understanding the key elements for successful teacher preparation and development. *Teaching and Teacher Education*, *140*, 104464. https://doi.org/https://doi.org/10.1016/j.tate.2023.104464

Legi, H., Damanik, D., & Giban, Y. (2023). Transforming education through technological innovation in the face of the era of society 5.0. *Educenter: Jurnal Ilmiah Pendidikan*, *2*(2), 102–108. https://doi.org/10.55904/educenter.v2i2.822

Maas, M. J., & Hughes, J. M. (2020). Virtual, augmented and mixed reality in K–12 education: A review of the literature. *Technology, Pedagogy and Education*, *29*(2), 231–249. https://doi.org/10.1080/1475939X.2020.1737210

Muzakki, A., Setiawan, E., Winarno, M. E., Gani, R. A., Yanti, N., Syamsudar, B., & Hofmeister, M. (2023). Increasing Physical Literacy in Pencak Silat Athletes: Two-Months Peer Teaching Model Program in COVID-19. *Physical Education Theory and Methodology*, *23*(1), 7–14. https://doi.org/10.17309/tmfv.2023.1.01

Nabil, N. R. A., Wulandari, I., Yamtinah, S., Ariani, S. R. D., & Ulfa, M. (2022). Analisis indeks Aiken untuk mengetahui validitas isi instrumen asesmen kompetensi minimum berbasis konteks sains kimia. *Jurnal Penelitian Pendidikan*, *25*(2), 184–191. https://doi.org/10.20961/paedagogia.v25i2.64566

Naibaho, D. P. (2023). Strategi Pembelajaran Berdiferensiasi Mampu Meningkatkan Pemahaman Belajar Peserta Didik. *Journal of Creative Student Research (JCSR)*, *1*(2), 81–91. https://doi.org/10.55606/jcsrpolitama.v1i2.1150

Nugroho, C. M. R., & Darmawan, P. (2024). Implementasi Pembelajaran Berdiferensiasi dalam Perspektif Teori Belajar Humanistik pada Sekolah Dasar: Studi Literatur. *Journal of Innovation and Teacher Professionalism*, *2*(3), 282–290. https://doi.org/10.17977/um084v2i32024p282-290

Nurkholis, M., & Weda. (2015). Implementasi Nilai – Nilai Pembentukan Sikap Dalam Pencak Silat Terhadap Perilaku Mahasiswa Prodi Penjaskesrek Unp Kediri. *Jurnal sportif*, *1*(1), 100–113. https://doi.org/10.29407/js_unpgri.v1i1.650

Permana, B. S., Hazizah, L. A., & Herlambang, Y. T. (2024). Teknologi pendidikan: efektivitas penggunaan media pembelajaran berbasis teknologi di era digitalisasi. *Khatulistiwa: Jurnal Pendidikan Dan Sosial Humaniora*, *4*(1), 19–28. https://doi.org/10.55606/khatulistiwa.v4i1.2702

Rahayu, T. W., Rozi, F., Nasir, M. Z. M., Priyono, B., & Difa, K. J. (2024). Augmented Reality in Breaststroke Swimming: Improving Techniques and Skills. *JOSSAE (Journal of Sport Science and Education)*, *9*(2), 113–120. https://doi.org/10.26740/jossae.v9n2.p113-120

Rosi, T., Onorato, P., & Oss, S. (2019). The Augmented Laboratory–a mixed reality setup for physics education. *Journal of Physics: Conference Series*, *1287*(1), 12059. 10.1088/1742-6596/1287/1/012059

Santoso, P. H., Istiyono, E., & Haryanto. (2022). Physics teachers' perceptions about their judgments within differentiated learning environments: A case for the implementation of technology. *Education Sciences*, *12*(9), 582. https://doi.org/10.3390/educsci12090582

Setyosari, H. P. (2016). *Metode penelitian pendidikan & pengembangan*. Prenada Media. ISBN : 978-602-0895-01-7

Sinulingga, A., Kasih, I., Hasibuan, S., Simatupang, N., & Daulay, D. (2024). Achieving Competency in Pencak Silat Courses Through the Application of Android Media. *Proceedings of the 5th International Conference on Innovation in Education, Science, and Culture, ICIESC 2023, 24 October 2023, Medan, Indonesia*. http://dx.doi.org/10.4108/eai.24-10-2023.2342096

Suroto, S., Kusnanik, N. W., Pradana, F. G. A., Prakoso, B. B., Bafirman, B., Barlian, E., … Wijaya, M. A. (2024). Education Profiling for East Java Student-Athletes: Planning, Process, Assessment, and Expectations. *JOSSAE (Journal of Sport Science and Education)*, *9*(1), 36–45. https://doi.org/10.26740/jossae.v9n1.p36-45

Sutrisno, L. T. (2023). Penerapan pembelajaran berdiferensiasi sebagai salah satu pemecahan masalah masih kurangnya keaktifan peserta didik saat proses pembelajaran berlangsung. *COLLASE (Creative of Learning Students Elementary Education)*, *6*(1), 111–121. https://doi.org/10.22460/collase.v1i1.16192

Syaifullah, R., & Maghribi, I. L. (2023). Speed analysis of the front kicks technique in 2022 pencak silat world champion athletes: Kinematic analysis. *Jurnal SPORTIF: Jurnal Penelitian Pembelajaran*, *9*(1), 146–159. https://doi.org/10.29407/js_unpgri.v9i1.19983

Tarekegn, K., & Mihiretie, D. M. (2024). Education policy intentions and principals' and teachers' conceptualizations of curriculum differentiation in Ethiopian secondary education. *Education Policy Analysis Archives*, *32*. https://doi.org/10.14507/epaa.32.8450

Wang, Y., Wu, J., Chen, F., & Li, J. (2024). Analyzing Teaching Effects of Blended Learning With LMS: An Empirical Investigation. *IEEE Access*, *12*, 42343–42356. https://doi.org/10.1109/ACCESS.2024.3352169

Wiguno, L. T. H., Kurniawan, A. W., Wahyudi, H., Puspitasari, D. F., & Salamuddin, N. (2024). Development of Basic Pencak Silat Techniques for High School Students. *JOSSAE (Journal of Sport Science and Education)*, *9*(1), 72-82. https://doi.org/10.26740/jossae.v9n1.p72-82

Yuliana, A., & Wahyudi, H. (2022). Analisis Kondisi Fisik Atlet Putri Pencak Silat Kategori Tanding Ekstrakurikuler Usia 15-16 Tahun SMA Negeri 12 Surabaya. *JOSSAE (Journal of Sport Science and Education)*, *7*(1), 34–41. https://doi.org/10.26740/jossae.v7n1.p34-41

Zakharov, P. V, Kataeva, A. S., Kochkin, A. S., Eremin, A. M., & Markidonov, A. V. (2020). Some aspects of using mixed reality technologies in the training of physics teachers. *Journal of Physics: Conference Series*, *1691*(1), 12015. 10.1088/1742-6596/1691/1/012015