An innovative approach in physical education: Exploring the impact of interactive virtual reality on motor skills

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An innovative approach in physical education: Exploring the impact of interactive virtual reality on motor skills

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ABSTRACT

Background Problems: Recent advancements in virtual reality (VR) technology have expanded its practical application in enhancing physical activity and motor skill acquisition among children. **Research Objectives**: This study aims to investigate the impact of interactive virtual reality software on the motor skills of 11- to 12-year-old elementary school children. **Methods**: Employing a quantitative approach with quasi-experimental methods, the research was conducted on 34 students from Lontar 481 Public Elementary School in Surabaya, selected through purposive sampling. The instruments used in the physical education learning process using virtual reality media include pre-test and post-test stages, which combine understanding of motor skills, practice, and evaluation by the teacher based on the correctness, fluency, and completeness of student actions. The procedure involved the treatment of experimental group subjects using virtual reality for 40 minutes in the control group, which was carried out conventionally. It was analysed using SPSS via a t-test, and the significance level was set at P < 0.05. **Findings/Results**: These findings showed a significant positive impact of virtual reality technology on students' motor development and confidence in performing movements, compared to the control group who underwent traditional learning. **Conclusion**: Research shows that utilising virtual reality programmes increases students' confidence in learning physical activities, especially for those at lower performance levels. The novelty of this research lies in its demonstration of virtual reality's capacity to improve children's motor competence in the context of physical education. Overall, the findings of this study contribute to physical activity and motor skills regarding the use of virtual reality media for elementary school children.

Keywords: Metaverse; virtual reality; physical education; motor skills

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INTRODUCTION

The development and reform of the education system are crucial, with a specific emphasis on leveraging technology effectively in the instruction of students, especially in physical education (Palao et al., 2015). Although recent years have seen significant progress in higher education, emphasising the need for comprehensive reform and improvement (Ding et al., 2020). In physical education, several challenges persist, such as a single educational approach, minimal intervals for skill development, and the absence of comprehensive technical evaluations. This statement is due to teachers lack skills and evaluation in the learning process, so this makes students feel that physical education learning is monotonous and poorly understood by students, resulting in a lack of interest

in learning which can affect the quality of learning (Chu et al., 2022). So that using virtual media in developing learning makes it easier for teachers and students to carry out the physical education learning process, especially motor skills. Apart from that, teachers and students are also actively involved in learning in order to avoid a single education approach. Teachers are expected to be able to train students in improving students' motor skills by using virtual media to increase fun learning. Teachers are expected to carry out evaluations in learning, especially in improving students' motor skills every month to determine students' understanding in each learning process.

However, providing quality physical education and physical activity becomes an increasingly difficult opportunity in schools when limited by many challenges such as a single educational approach, limited skill development intervals, and the absence of comprehensive technical evaluation (Rocliffe, O'Keeffe, Sherwin, Mannix-McNamara, & MacDonncha, 2023). We believe that the solution lies in applying advanced technologies, such as virtual reality (VR), in the metaverse, which can enhance sports training and support students' motor skill development. With this approach, we hope to overcome barriers in physical education that can adversely affect students' motor skills, including locomotor movements and object control (Pratama et al., 2022). To overcome barriers in physical education, we take an approach using "Metaverse" with virtual reality that can be accessed quickly using any device around the world (Feng, 2023). This research introduces the implementation of IoT-based virtual reality within the metaverse for sports education, emphasizing the potential for enhancing sports training.

For optimal enhancement and innovation of current educational models and methods in physical education, schools, teachers, and physical education must embrace advanced technologies and metaverse concepts aligned with their capabilities and goals (Guo & Gao, 2022). The integration of metaverse technology in physical education is a growing field, displaying significant potential as a future education trend (Guo & Gao, 2022). Utilizing existing technology tailored for excellence in physical education is crucial in creating an effective learning environment (Wang et al., 2019). Acquisition of scientific knowledge regarding physical activity is essential for students to become physically literate for life. Cognitive engagement and cognitive task levels significantly influence the effectiveness of knowledge acquisition (Wang et al., 2019). The application of advanced technologies, including the metaverse, facilitates sports activities within schools (Seshadri et al., 2019).

The continuous advancement of virtual reality technology and the integration of the internet offer promising possibilities for the enhancement of physical education (Mokmin & Jamiat, 2021). Digital reality technology is increasingly popular in supporting students' physical activities, particularly in physical education (Mokmin & Jamiat, 2021). However, research specifically exploring digital reality in physical education classes is limited (Lee & Lee, 2021). The application of virtual reality in physical education has the potential to revolutionize future educational practices (Yang, 2022). Combining computer science and simulation technology, digital reality technology enhances learning experiences by providing sensory stimulation and immersive learning environments (Ding et al., 2020). The emergence of the Internet of Things (IoT) has also driven innovation in sports training (Yu & Mi, 2023). A recent paradigm, focused on the concept of the metaverse, has emerged (Suh & Ahn, 2022). Extensive efforts and research have been invested in developing metaverse technology, although primarily based on fictional novels rather than existing as practical technology (Kye et al., 2021). Thus, physical education stands to benefit from metaverse technology (Feng, 2023).

Previous research by Zhang et al. (2021) demonstrated that immersive virtual reality in physical education significantly increased students' interest in learning and efficiency.

VR was found to be efficacious in rehabilitation, particularly for children with various disorders (Zhang, 2020). Additionally, AR-assisted instruction was found to be more effective than video-assisted instruction, particularly for learning challenging motor skills (Chang et al., 2020). However, past literature has primarily discussed metaverse-related technologies in education separately, rather than from an educational perspective (Zhang et al., 2022).

The integration of metaverse technology can enhance engagement and understanding of sports knowledge, revolutionizing traditional learning models (Camas et al., 2021). Comparatively, using virtual reality technology in practical education models significantly improves students' physical assessment results (Yu & Mi, 2023). Digital reality offers benefits in motor learning and physical activity (Dumuid et al., 2017). Innovative teaching aids such as IoT and virtual reality have immense potential to enhance teaching quality, teaching effectiveness, and promote outstanding sports skills (Yu, 2022). Under the new metaverse-based physical education system, teachers, and students can seamlessly perceive the blend of virtual and real elements through auditory, visual, and tactile senses (Suh & Ahn, 2022). However, despite the potential benefits of virtual reality, more research is needed to understand its effects and applications, particularly in children with motor challenges.

Although there has been extensive international research regarding learning using virtual reality media (Zhang et al., 2021; Chang et al., 2020; Dumuid et al., 2017; Yu, 2022; Suh & Ahn, 2022; Garduño et al., 2021), but there is still a gap in understanding teachers' perceptions of the application of virtual reality in physical education, especially in the context of quantitative research methodology. This study presents something new in terms of analyzing physical education learning skills, especially skills for improving children's motor skills through quantitative research methods. It is hoped that this research can make an important contribution to stakeholders, for example physical education teachers, regarding the implementation of the use of virtual reality media in the context of physical education information, so that later learning outcomes through virtual reality media can be achieved more optimally. Therefore, our research aims to explore the impact of interactive virtual reality applications on the motor skills of elementary school children aged 11-12 years.

This research is very important to do because it can help students gain a better understanding of motor skills. In addition, the VR learning system may be more helpful to students by using more visual angles than the video instruction used in the experimental group. The implementation in this research is a VR-based physical education program that is effective in improving locomotor skills in elementary school children. Motor skills in children are very important for the development of children's physical motor activity levels. Virtual reality (VR) training may be useful in this regard. VR training is based on information-based theory of motor skills.

METHOD

This study integrated information technology into physical education to create optimal 3D dynamic motor skills using virtual reality, aligning with teaching objectives and motor skills essence. A quantitative approach with quasi-experimental methods was employed, conducted on 34 students 481 Public Primary School of Lontar Surabaya, selected based on body mass index of 21.3 KG/m2, using purposive sampling.

Data collection for basic motor skills utilized the Motor Development Test-2 (TGMD-2) (Jell, 2017; Pratama et al., 2022). The collected data encompassed motor skills assessments before and after the learning sessions. The research procedure was as follows: First, the experimental group used metaverse virtual reality media software, guided by a physical education teacher which lasted for 40 minutes and focused on

movement skills. Second, the application of media in digital reality begins with an introduction and direct guidance from a physical education teacher. Third, Virtual Reality Media Program Used in the physical education learning process, this program includes pretest and posttest stages, combining understanding of motor skills, practice, and evaluation by the teacher based on correctness, fluency, and completeness of student actions.

These programs include: Stage 1: Pretest and posttest for the first lesson on motor skills understanding and concepts, showcasing methods, and engaging in motor skill exercises. Stage 2: Pretest and posttest for the second lesson on motor skills, accompanied by detailed demonstrations and explanations, followed by relevant exercises. Integration of virtual reality into physical education was aimed at achieving the learning objectives and enhancing the teaching process, thus contributing positively to the students' motor skill development and engagement. It was analyzed using SPSS statistical software IBM version 25.0 via t-tests (data exposure, paired check, and independent sample test).

Table 1. Basic Motor Program Components as Follows

Locomotor Subtest	Object Control Subtest
Run	Striking a Stationary
Gallop	Ball
Hop	Stationary Dribble
Leap	Catch
Horizontal Jump	Kick
Slide	Ovehand Throw Underhand Roll

(Jell, 2017)

Table 2. Physical Education Activity Learning Program as Follows

No	Program Type (Physical Education)
1	Standing long jump (SLJ)
2	Sit and reach (S&R)
3	Sit-up (S-U)
4	Suttle run (SR)

(Lee et al., 2023)

RESULTS AND DISCUSSION

After looking at the test results used virtual reality in physical education, several stages were found that could be explained; descriptive analysis and paired t test.

Table 3. Description of Research Results

Group		N	Minimum	Maximum	Mean	SD	Variance
Experiment	Pretest	17	60	80	70.02	5.852	43.778
	Posttest	17	110	124	116.23	6.825	90.041
Control	Pretest	17	85	102	88.57	4.189	101.519
	Posttest	17	89	101	90.01	4.264	78.174

The presented table data reveals significant findings. In the experimental group, the pre-test scores ranged from a minimum of 60 to a maximum of 80, with a mean of 70.02, standard deviation of 5.852, and variance of 43.778. Post-test scores exhibited a range from 110 to 124, with a mean of 116.23, standard deviation of 6.825, and variance of 90.041. For the control group, pre-test scores varied from a minimum of 85 to a maximum of 102, resulting in a mean of 88.57, standard deviation of 4.189, and variance of 101.519. In the post-test, scores ranged from a minimum of 89 to a maximum of 101, with a mean of 90.01, standard deviation of 4.264, and variance of 78.174. These findings indicate a notable improvement in basic motor skills within both groups.

Table 4. Paired T-test

Group		Mean	T	Df	Sig (2-tailed)
Experiment	Pretest-posttest	-13.821	-15.252	35	.000
Group	Pretest-posttest	-2.232	-2.257	35	.015

To assess the impact of virtual reality on motor skills, paired t-tests were conducted, and the following results depict the analysis for both the experimental and control groups. The control group received traditional physical education. From the table above, it is evident that the 2-tailed significance (sig) was calculated as 0.000, which is less than 0.005, indicating a significant impact of virtual reality on motor skills for the experimental group at 481 Public Primary School of Lontar Surabaya. Moreover, the control group also exhibited a discernible impact, with a sig value of 0.015, still less than the significance level of 0.05. The progress in both groups is evident through an independent assessment of the paired t-tests, further emphasizing the positive influence of virtual reality on enhancing motor skills.

Table 5. Variations in Development in Every Institution

		F	Sig.	T	Df	Sig (2-tailed)
Motor skill	Equal Variances assumed	2.676	.045	13.447	65	.001

The provided table indicates a two-tailed significance (sig) of 0.001, which is less than 0.005, implying that the virtual reality group exhibits distinct motor skills compared to the control group. Ericsson and Karlsson (2014) support the idea that interventions involving physical activity through virtual reality enhance motor skills and contribute to increased physical activity in children. Virtual reality proves to be more effective than other technologies, emphasizing the necessity to study its influence on students in physical education within the realm of sports.

Results of research conducted at 481 Public Primary School of Lontar Surabaya using virtual reality in physical education showed that it had a positive influence between the experimental group and the control group so that students' focus during the learning process increased. This means that the use of virtual reality has a better learning effect for the operation of skills motor. Students enjoyed using digital reality technology, finding it engaging and exciting for learning (Lee & Lee, 2021). Virtual reality stands as a unique and valuable tool for researchers and practitioners in the realm of motor learning (Osumi et al., 2019).

This research is very important to do because it can help students gain a better understanding of motor skills. In addition, the VR learning system may be more helpful to students by using more visual angles than the video instruction used in the experimental group. The implementation in this research is a VR-based physical education program that is effective in improving locomotor skills in elementary school children. Motor skills in children are very important for the development of children's physical motor activity levels. Virtual reality (VR) training may be useful in this regard. VR training is based on information-based theory of motor skills.

Item (image) recognition is highly valuable in conveying various information about objects in the form of 3D images and sounds, aligning with the physical nature of the object in physical education topics for elementary schools. The experimental group, utilizing virtual reality technology, showed significant progress in motor development and increased confidence in performing movements compared to the control group following traditional learning methods. The education sector needs to keep pace with science and technology advancements, continually enhancing the learning environment

and teaching tools through reality technology across subjects.

Physical education employing virtual reality technology proves to be more effective in engaging students compared to traditional learning methods, aligning with prior research (Wang & Mughaid, 2022). Consequently, students in elementary schools are intrinsically motivated and improve their motor skills, encouraging continuous learning in the future. This corresponds with the outcomes of the study (Lee & Lee, 2021), where higher motor skills correlate with higher satisfaction levels. Thus, virtual reality technology challenges students to learn and improve their motor skills. A study by Meng (2021) reported an increase in students' interest in using virtual reality technology across five schools.

Research demonstrates that virtual reality can stimulate early motor competence development in children (Zhang, 2020). A virtual reality system was developed in this study to enhance the attention of elementary school students (Tarng et al., 2022). The experimental group outperformed the control group as virtual reality education enabled students to focus on a specific task for an extended period. These results align with research by Grabowski and Jankowski (2015), which highlighted how virtual reality training can enhance children's attention. Therefore, teachers can incorporate virtual reality games with students' consent to reinforce motor skills, subsequently enhancing learning effectiveness. Virtual reality training can integrate essential information intervention through simulation games, allowing children to learn and apply this perception-action relationship at their own pace, maximizing motor skill learning (Kiefer et al., 2017).

The weakness in this research is in the practical application of physical education, which proves that learning models need to be improved, especially virtual learning models, immersive physical education model learning. This research has the following limitations. First, all included studies were intervention studies, but the VR implementation approaches varied, thereby reducing the final conclusion of VR effects. Second, the small number of studies included in the analysis limits the examination of potential moderator variables such as regional culture, scale, and virtual reality device. Third, most of the included studies were single studies of short-term interventions, and the lack of adequate long-term follow-up studies made it impossible for researchers to evaluate whether the impact of virtual reality on individual motor skills was stable in the long term.

The difference between this research and the previous research is the research of (Lee & Lee, 2021) which states that higher motor skills accumulate with higher levels of satisfaction. Research by Grabowski and Jankowski (2015) states that virtual reality training can increase children's attention. Meanwhile, this research states that virtual reality in physical education shows a positive influence between the experimental group and the control group so that students' focus during the learning process increases. What this research has in common with previous research is using virtual reality in the physical education learning process.

This research is limited to the elementary school system, where not all students bring mobile phones to school, and it is restricted to grade 6 physical education students at 481 Public Primary School of Lontar Surabaya. For future research, similar studies should be conducted using different methodologies, and interactive virtual reality media should be developed, considering the latest technological advancements and trends in physical education subjects. It is hoped that the results of this research in the future will be able to integrate virtual reality technology into the learning process. This integration can significantly increase students' enthusiasm, participation in physical education learning, and ultimately improve children's motor skills.

CONCLUSION

Virtual reality has the potential to increase physical activity and encourage active motor development in elementary school children. The results of statistical analysis showed that the virtual reality experimental group showed more significant progress than the control group. This is due to the repetitive and immersive experiences that virtual reality technology offers students. The novelty of this research highlighted that virtual reality holds promise in improving children's motor competence in physical education. Metaverse technology can not only ignite students' enthusiasm for learning but also deepen their understanding of sports science. Digital reality sports provide a variety of successful experiences for students with low motor skills because they can adjust the level of difficulty.

CONFLICT OF INTEREST

The authors have no conflict of interest to declare.

REFERENCES

Camas, L., Valero, A., & Vendrell, M. (2021). The teacher-student relationship in the use of social network sites for educational purposes: A systematic review. *Journal of New Approaches in Educational Research, 10*(1), 137-156. https://doi.org/10.7821/naer.2021.1.591

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

Chu, Y., Chen, C., Wang, G., & Su, F. (2022). The effect of education model in physical education on student learning behavior. *Frontiers in Psychology, 13*, 944507, 1-13. https://doi.org/10.3389/fpsyg.2022.944507

Ding, Y., Ding, Y., Li, Y., & Cheng, L. (2020). Application of internet of things and virtual reality technology in college physical education. *IEEE Access, 8*, 96065–96074. https://doi.org/10.1109/ACCESS.2020.2992283

Dumuid, D., Olds, T., Lewis, L. K., Martin-Fernández, J. A., Katzmarzyk, P. T., Barreira, T., Broyles, S. T., Chaput, J.-P., Fogelholm, M., Hu, G., Kuriyan, R., Kurpad, A., Lambert, E. V, Maia, J., Matsudo, V., Onywera, V. O., Sarmiento, O. L., Standage, M., Tremblay, M. S., ... Maher, C. (2017). Health-Related Quality of Life and Lifestyle Behavior Clusters in School-Aged Children from 12 Countries. *The Journal of Pediatrics*, (183), 178-183.e2. https://doi.org/10.1016/j.jpeds.2016.12.048

Ericsson, I., & Karlsson, M. (2014). Motor skills and school performance in children with daily physical education in school: A 9-year intervention study. *Scandinavian Journal of Medicine & Science in Sports, 24*, 273-278. https://doi.org/10.1111/j.1600-0838.2012.01458.x

Feng, J. (2023). Application and exploration of the innovation of physical education model empowered by the metaverse technology. *Curriculum and Teaching Methodology*, *6*(1), 123–127. https://doi.org/10.23977/curtm.2023.060120

Grabowski, A., & Jankowski, J. (2015). Virtual reality-based pilot training for underground coal miners. *Safety Science, 72*, 310–314. https://doi.org/10.1016/j.ssci.2014.09.017

Guo, H., & Gao, W. (2022). Metaverse-powered experiential situational english-teaching design: an emotion-based analysis method. *Frontiers in Psychology, 13*, 1-9. https://doi.org/10.3389/fpsyg.2022.859159

Jell, C. (2017). Gross Motor Development. *Early Years Educator, 18*(10), 8–9. https://doi.org/10.12968/eyed.2017.18.10.viii

Kiefer, A. W., Pincus, D., Richardson, M. J., & Myer, G. D. (2017). Virtual reality as a training tool to treat physical inactivity in children. *Frontiers in Public Health*, *5*, 1–7. https://doi.org/10.3389/fpubh.2017.00349

Kye, B., Han, N., Kim, E., Park, Y., & Jo, S. (2021). Educational applications of metaverse: possibilities and limitations. *Journal of Educational Evaluation for Health Professions*, *18*(32), 1-13. https://doi.org/10.3352/jeehp.2021.18.32

Lee, H. S., & Lee, J. (2021). The effect of elementary school soccer instruction using virtual reality technologies on students' attitudes toward physical education and flow in class. *Sustainability (Switzerland)*, *13*(6), 1-17. https://doi.org/10.3390/su13063240

Lee, J., Yoon, H. K., & Kim, D. (2023). Design of metaverse-based physical fitness service for the enhancement of exercise capability for youth. *Mobile Information Systems*, (2023), 1-19. https://doi.org/10.1155/2023/7272781

Meng, J. (2021). College physical education teaching aided by virtual reality technology. *Mobile Information Systems*, (2021), 1–11. https://doi.org/10.1155/2021/3052895

Mokmin, N. A., & Jamiat, N. (2021). The effectiveness of a virtual fitness trainer app in motivating and engaging students for fitness activity by applying motor learning theory. *Education and Information Technologies, 26*(2), 1847-1864. https://doi.org/10.1007/s10639-020-10337-7

Osumi, M., Inomata, K., Inoue, Y., Otake, Y., Morioka, S., & Sumitani, M. (2019). Characteristics of phantom limb pain alleviated with virtual reality rehabilitation. *Pain Medicine (Malden, Mass.)*, *20*(5), 1038–1046. https://doi.org/10.1093/pm/pny269

Palao, J. M., Hastie, P. A., Cruz, P. G., & Ortega, E. (2015). The impact of video technology on student performance in physical education. *Technology, Pedagogy and Education, 24*(1), 51–63. https://api.semanticscholar.org/CorpusID:62676504

Pratama, B. A., Sucipto, S., & Nanda Hanief, Y. (2022). Improving learning in physical education: augmented reality mobile app-based for fundamental motor skill. *Jurnal SPORTIF: Jurnal Penelitian Pembelajaran*, *8*(2), 314–326. https://doi.org/10.29407/js_unpgri.v8i2.18508

Rocliffe, P., O'Keeffe, B. T., Sherwin, I., Mannix-McNamara, P., & MacDonncha, C. (2023). School-based physical education, physical activity and sports provision: A concept mapping framework for evaluation. *Plos one*, *18*(6), e0287505. https://doi.org/10.1371/journal.pone.0287505

Seshadri, D. R., Li, R. T., Voos, J. E., Rowbottom, J. R., Alfes, C. M., Zorman, C. A., & Drummond, C. K. (2019). Wearable sensors for monitoring the internal and external workload of the athlete. *NPJ Digital Medicine*, *2*(71), 1-18. https://doi.org/10.1038/s41746-019-0149-2

Suh, W., & Ahn, S. (2022). Utilizing the metaverse for learner-centered constructivist education in the post-pandemic era: An analysis of elementary school students. *Journal of Intelligence*, *10*(1), 1-15. https://doi.org/10.3390/jintelligence10010017

Tarng, W., Pan, I. C., & Ou, K. L. (2022). Effectiveness of virtual reality on attention training for elementary school students. *Systems*, *10*(4), 1-24. https://doi.org/10.3390/systems10040104

Wang, Y., Chen, A., Schweighardt, R., Zhang, T., Wells, S., & Ennis, C. (2019). The nature of learning tasks and knowledge acquisition: The role of cognitive engagement in physical education. *European Physical Education Review*, *25*(2), 293–310. https://doi.org/10.1177/1356336x17724173

Wang, Y., & Mughaid, A. (2022). Design of a virtual reality-based learning system for spoken english. *International Journal of Emerging Technologies in Learning*, *17*(24), 25–41. https://doi.org/10.3991/ijet.v17i24.35655

Yang, Z. (2022). Digital transformation to advance high-quality development of higher education. *Journal of Educational Technology Development and Exchange*, *15*(2), 15–23. https://doi.org/10.18785/jetde.1502.02

Yu, H., & Mi, Y. (2023). Application model for innovative sports practice teaching in colleges using internet of things and artificial intelligence. *Electronics (Switzerland)*, *12*(4), 1-10. https://doi.org/10.3390/electronics12040874

Yu, J. E. (2022). Exploration of educational possibilities by four metaverse types in physical education. *Technologies*, *10*(5), 1-11. https://doi.org/10.3390/technologies10050104

Zhang, T. (2020). Virtual reality and its effectiveness on motor development and rehabilitation in children with disorders. *American Journal of Biomedical Science & Research*, *7*(3), 269–273. https://doi.org/10.34297/ajbsr.2020.07.001156

Zhang, X., Chen, Y., Hu, L., & Wang, Y. (2022). The metaverse in education: definition, framework, features, potential applications, challenges, and future research topics. *Frontiers in Psychology*, *13*(10), 1–18. https://doi.org/10.3389/fpsyg.2022.1016300

Zhang, X., Shi, Y., & Bai, H. (2021). Immersive virtual reality physical education instructional patterns on the foundation of vision sensor. *Journal of Sensors*, 2021(16), 1-12. https://doi.org/10.1155/2021/7752447

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7   Budiman Agung Pratama, Sucipto Sucipto, Yulingga Nanda Hanief. "Improving learning in physical education: Augmented reality mobile app-based for fundamental motor skill", Jurnal SPORTIF : Jurnal Penelitian Pembelajaran, 2022
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