Jurnal Patriot
E-ISSN: 2714-6596 P-ISSN: 2655-4984
Homepage: http://patriot.ppj.unp.ac.id/index.php/patriot
Vol. 6 (Issue 1), 2024, pp. 13-20

Development of digital-based return board table tennis learning media

Agus Gumilar[1]*, Jajat Darajat Kusumah Negara[2], Nuryadi[3], Helmy Firmansyah[4], Mudjihartono[5] , Burhan Hambali[6], Eko Purnomo[7]

[1,2,3,4,5,6]Faculty of Sports Health and Recreation Education, Universitas Pendidikan Indonesia, Bandung, INDONESIA.
[7]Department of Coaching, Faculty of Sport Science, Universitas Negeri Padang, INDONESIA.

Article Information:
Submitted: 12 February 2024; Accepted: 16 March 2024; Published: 21 March 2024

ABSTRACT

Problems: Technology is very important in sports, both on and off the field. The use of technology-based applications in sports is very important in supporting athlete training systems and producing accurate data for measuring sports performance. **Purpose**: This research involves developing a conventional return board into a digital-based return board. Digital return board media can be used as a learning, evaluation, and coaching medium in table tennis games. The research carried out is research and development. **Methods**: Research and development (R&D) research is essentially an effort to develop a prototype of a research-based tool or device, namely the digitization of conventional return boards. After the media return board is produced, the next stage is to carry out analysis by validating the digital return board by experts. **Results**: The research used three experts, namely practitioner experts represented by test and measurement course lecturers, media experts who were experts in the field of computer programming, practitioners who were trainers, and professional athletes. Each expert will analyze each trial from a small scale to a large scale. The three experts gave an average of the test results on a scale of 80% after going through three stages, so this return board was deemed to meet the requirements to be used as a training and learning medium in table tennis games. **Conclusion**: It is hoped that the results of this research can become a technological medium in table tennis playing activities, especially in improving the performance of table tennis players based on accurate data.

Keywords: Digital Return Board, Sports Technology, Table Tennis

https://doi.org/10.24036/patriot.v4i3.856

Corresponding Author:
Agus Gumilar
Faculty of Sports Health and Recreation Education, Universitas Pendidikan Indonesia, Bandung, INDONESIA.
Email: gumilaragus27@upi.edu

Introduction

Sports technology is a certain type of means for realizing human interests and goals in sports. These technologies range from body techniques and sports equipment used by athletes in competition to machines, substances, and methods used outside the competition environment to enhance performance (Loland, 2002). Technology in sports plays an important role both on and off the field (Schmidt, 2020). The use of technology-based applications in sports in various places is increasingly widespread, including sports facilities, communication systems, ticket access, information systems, television, command and control systems, but also in action, including the use of computer technology, analysis, computerization of athlete training, sports training systems, and data entry systems (Can et al., 2011). The role of technology can be expanded and is very important in the formation of a more technologically advanced society (Silverman, 1997).

Meanwhile, the use of multimedia technology in physical education has become a trend in sports, especially in teaching and training. Information technology stimulates student interest and increases students' knowledge and understanding (Can et al., 2011). The application of video technology and teacher feedback provided the most positive results, with statistically significant improvements in the implementation of skills, techniques, and knowledge learning, as well as practical skills (Palao et al., 2015). Research related to the use of mobile technology in badminton learning to increase students' motivation and badminton skills. Straub & Klein-Soetebier (2017) underline the importance of systematic match

analysis in coaching and player development. These studies collectively contribute to a deeper understanding of the science behind table tennis.

Advances in equipment design can improve performance to such an extent that it can even become a medium for learning or practicing in sports. This has revolutionized the competition for engineers to develop equipment that can improve performance in sports (Stefanyshyn & Wannop, 2015). he success of a learning process must, of course, be supported by good facilities and infrastructure to achieve maximum results (Yudiana et al., 2021). The most sophisticated learning medium in table tennis has been developed, namely by using return board media.

Research on return boards in table tennis is limited, but research on related topics provides some information. Avilés et al (2019) found that expert tennis players did not act anticipatory when they returned the first serve, indicating that similar behavior can be seen in table tennis performed at a university badminton club with the involvement of 225 students. The participants were divided into two groups, one using tablet course group (TCG) technology and the other using conventional course group (CCG), namely using conventional face-to-face methods. By using qualitative and quantitative approaches, research results show that learning motivation and performance of badminton skills at TCG are significantly better than at CCG (Hung et al., 2018). Mohnsen et al (1999) developed a multimedia system that helps analyze sports skills in children. Their system is designed to allow students to compare the execution of motor skills.

A number of studies have explored the scientific aspects of table tennis. Fuchs et al (2018) provide a comprehensive review of fit analysis methods, including performance indices, simulative approaches, and momentum analysis. Wong et al (2020) focused on the biomechanics of table tennis strokes, highlighting the differences between levels of play and movement maneuvers. Ferrández et al (2020) discussed the physiological and biomechanical aspects of sport, emphasizing the need for further research into energy flow and prevention. Huang et al (2023) provide recommendations for training media for table tennis players, which can be implemented through training using a return board. Courtemanche et al (2020) observed brain activity involved in tennis serve returns, which may be relevant to understanding the cognitive processes that occur when playing with a return board. Finally, Biz et al (2022) draw attention to the risk of injury in table tennis, which may be considered for those using a return board. However, to reach clearer conclusions, further research is needed, especially regarding the use of return boards in table tennis. In table tennis learning, both in carrying out tests, training, and the learning process of table tennis courses, there is still minimal use of digital-based media. This is the author's concern for conducting science-based research and the application of science and technology for the needs of developing technological media in sports, as well as becoming an innovation in learning through the application of digital tools within the Indonesian University of Education. Therefore, the author intends to develop digital-based table tennis return board learning media.

Method

The research carried out is research and development. Research and development (R&D) research is essentially an effort to develop a prototype of a research-based tool or device (Ali, 2011), Research has four main characteristics, namely: (1) studying research findings as participants in the product to be developed; (2) developing the product based on these findings; (3) field testing in the setting where it will be used eventually; and (4) revising it to correct the deficiencies found in the field-testing stage (Borg & Gall, 1984). In this research, we are developing a conventional return board into a digital-based return board. Digital return board media can be used as a learning, evaluation, and coaching medium in table tennis games.

Digital Return Board Prototype Product Creation Stage

The planning and initial product creation stage contains the activity of making a digital return board prototype in accordance with the prototype design that was previously drawn. The manufacturing process is as depicted in Figure 1 below:

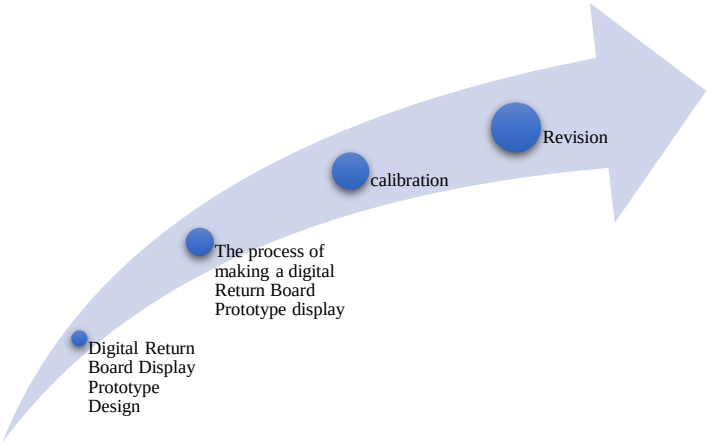

Figure 1. Process of making a digital return board prototype

The process of making a digital display return board prototype begins by creating a design in the form of a design and layout of a digital display return board, followed by the production process of making a digital display return board prototype. In this stage, the researcher collaborates with computer and sensor system experts in developing the media. The third stage is calibration, the meaning of calibration according to ISO/IEC Guide 17025:2005, and the vocabulary of international metrology (VIM) is a series of activities that establish a relationship between the values shown by a measuring instrument or measurement system, or the values represented by measuring materials, with the values It is already known that it is related to the quantity measured under certain conditions (Hadi, 2018). The final process is to revise the media that has been calibrated if there are items that are still missing and must be completed. For the return board itself, use the return board, which is available under the Shiamiq brand..

Results

After going through the process of making a digital display prototype, the display is combined with the return board using a vibration sensor connected to the display, and the design and shape of the digital return board media are clearer, as seen in Figures 2 and 3 below.

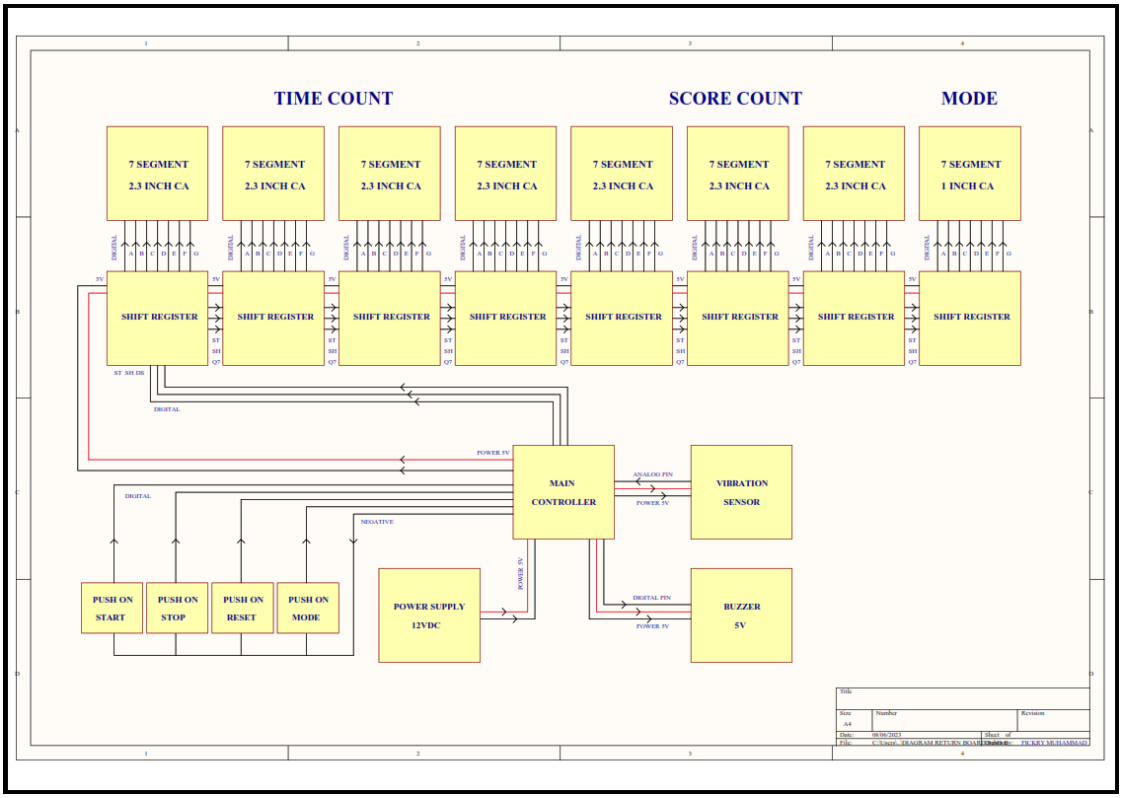

Figure 2. Digital Return Board Display Prototype

Figure 3. Digital Return Board

After the media return board is produced, the next stage is to carry out analysis by validating the digital return board by experts (Darajat & Abduljabar, 2014). This is in line with qualitative and quantitative research approaches with the aim of finding answers to problems through formulated problem formulations. 56 Sports Window, Research and Development Model Method (Borg & Gall, 1984).

Table 1. Expert Evaluation Instruments Digital Return Board Development Tools

Concepts	Variables	Indicator	Sub-Indicator
Development of a digital return board for the sport of table tennis	Suitability of the digital return board for the sport of table tennis	Initial Stage	1. Digital return board display material: shape and size 2. Suitability of the digital return board function
		Implementation	1. Reflection 2. Error rate 3. Objectivity 4. Efficiency
		Final Stage	1. Final implementation 2. Tool sensitivity 3. Effectiveness 4. Final data 5. Hardware suitability

The researcher gave a questionnaire, as shown in Table 1, which is an instrument given to experts to test the validity of the tool, namely academics, technicians, and practitioners. Academic experts are lecturers who are experts in looking at the procedures and validity of the tool as a new measuring tool; technician experts are IT experts and hardware computing technology; and practitioners are table tennis coaches and athletes with national licenses. In filling out the questionnaire, researchers use a Likert scale to measure the attitudes, opinions, and perceptions of a person or group of people about this social phenomenon, which has been determined specifically by the researcher and is hereinafter referred to as the research variable.

With a Likert scale, the variables to be measured are translated into indicator variables. Then these indicators are used as a starting point for compiling instrument items, which can be in the form of statements or questions. The answer to each instrument item using a Likert scale has a gradation from very positive to

very negative. For this reason, researchers in this study used the following answers and scores: strongly agree = 5; agree = 4; undecided = 3; disagree = 2; and strongly disagree = 1.

From the results of interviews with two academics who lectured on measurement tests and table tennis, the following results were obtained: (1) There is a need for the development of technology as an application of scientific disciplines; (2) To minimize errors due to human error, sensor sensitivity settings must be determined.

The research used three experts, namely practitioner experts represented by test and measurement course lecturers, media experts who are experts in the field of computer programming, practitioners who are coaches, and professional athletes. Each expert will analyze each trial from a small scale to a large scale. The three experts gave an average of the test results on a scale of 80%, so this research was successful.

Table 2. Results of the expert assessment of the model developed

Stage 1: Initial Draft Model		
Academic expert	Technician expert	Practitioner expert
60%	40%	65%
Stage 2 Small Scale Draft Model		
Academic expert	Technician expert	Practitioner expert
75%	70%	72%
Stage 3 Large Scale Draft Model		
Academic expert	Technician expert	Practitioner expert
85%	82%	86%

In small group testing, field testing, and testing the effectiveness of the model developed, it was discovered that the flexibility measurement test development product was considered effective and met the requirements to be applied in training activities and table tennis skill tests. Based on data that can be collected from academic experts, technicians, and practitioners, as well as data collected during small group tests and field tests from test participants, there are several parts of the product that have undergone modifications.

This is done to maximize the benefits of developing testing tools that measure sensor sensitivity. Below, we will explain several things related to the first stage assessment, the second stage assessment, and the third stage assessment.

The first stage of revision was carried out after the draft proposals that had been made by the researchers were given to the experts to be used as material for the researchers to consider in small-scale trials. Based on the validation results from five experts, there is a slight change in the sensor model used from a cable system to a direct connection system.

The second stage of revision was carried out after receiving input and suggestions from experts, and the tool will be used in small-scale trials. In this trial, there were several inputs regarding the sensor sensitivity calibration, which was made where the sensitivity of the impact of the ball and the return board media was not yet stable, and the slope of the return board during the table tennis skill test.

The third-stage revision was carried out after receiving criticism and suggestions regarding the comprehensive trial. A third stage revision or revision of the final product was carried out. The data obtained from this large-scale testing is the basis for reviewing the final stages of product development for digital return boards for table tennis games. Based on field tests, it turns out that there is no product for the development of flexibility measuring instruments that needs to be modified in all its aspects and meets the standards and suitability of the product for use.

Discussion

It is hoped that the development of this digital return board can make a positive contribution to table tennis playing skills. Research has shown that the return board helps people become better at playing table tennis. Wasan (2020) found that the return board tool significantly increased forehand spin ability in tennis athletes. Likewise, Hanim & Tomoliyus (2018) showed that the return board device effectively improved punch drive skills in novice players. The use of physical and aerodynamic models in racket control to return table tennis balls was proposed by (Liu et al., 2012, 2013) and suggests a modified algorithm for real-time processing. These studies collectively highlight the potential of using return board media to improve table tennis training and performance. Apart from robots, the use of return board media is also used both in the learning process and in table tennis practice. Return board aids can be used to improve athletes' ability to execute topspin forehand strokes. The use of a return board is 53% effective for beginner athletes and 32%

effective for advanced athletes. This product can also be used as a training tool for junior, beginner, and senior athletes (Santosa et al., 2017).

The evolution of table tennis technology has had a significant impact on the sport, with innovations such as lightweight rackets, training robots, and data analysis tools improving player performance and experience (Udomvirojsin & Vongsrangsap, 2023). Biomechanical studies have increased our knowledge of this sport, especially fast break and curveball techniques (Jun, 2014). The integration of wireless sensor networks and data mining has improved the collection and analysis of suitability parameters, leading to the development of strategic analysis systems (Ma, 2020). Shot analysis, tracking, and strategy training analysis are some of the AI technologies that have been used in table tennis, which have resulted in table tennis robots and training assistance systems (Kong & Tanaka, 2021).

Various technological advances have been made in the field of ping pong. Hashimoto et al (1987) developed a ping pong robot system with a 7-degree-of-freedom direct drive arm that allows real-time performance of unstructured tasks.. Gao et al (2014) introduced a 3D augmented reality ping pong game system for Android, providing a more convenient and interesting way to play the game.. Matthews & Cottrell (2000) examined the PingER project, which tracked the performance of high-energy particle and nuclear physics experiments over the Internet applied to table tennis. Finally, Yamashita & Kobayashi (2018) presented a smart ping pong racket equipped with a very thin piezoelectric strain sensor array. This sensor suite allows for comprehensive ball impact identification and shot type classification. These innovations have significantly improved the playing experience and ability to practice the sport of ping pong.

To improve table tennis skills, various learning models, training programs, and different learning media are needed. Virtual reality (VR) training has shown potential for improving real-world table tennis playing skills. Participants in VR training showed significant improvements in their table tennis skills compared to the control group based on quantitative and qualitative performance metrics (Michalski et al., 2019). The use of application-based learning media has proven effective in increasing students' understanding and skills regarding basic table tennis technical material (Gumilar et al., 2022; Siregar et al., 2023).

Conclusion

It is hoped that the development of this digital backboard can contribute to improving competitive table tennis abilities. Model effectiveness testing, small group testing, and field testing show that the flexibility measurement test product is assessed as effective and meets the requirements for use in table tennis practice and skill tests. Experts analyze each trial from small scale to large scale and provide an average result of 80% of the trial scale after the research is successful. Research shows that digital return boards can be used for better training activities and table tennis playing activities. It is hoped that the results of this research can become a technological medium in table tennis playing activities, especially in improving the performance of table tennis players based on accurate data.

References

Ali, M. (2011). *Memahami Riset Prilaku dan Sosial*. Pustaka Cendekia Utama.

Avilés, C., Navia, J. A., Ruiz, L. M., & de Quel, Ó. M. (2019). Do expert tennis players actually demonstrate anticipatory behavior when returning a first serve under representative conditions? A systematic review including quality assessment and methodological recommendations. *Psychology of Sport and Exercise*. https://api.semanticscholar.org/CorpusID:149586356

Biz, C., Puce, L., Slimani, M., Salamh, P. A., Dhahbi, W., Bragazzi, N. L., & Ruggieri, P. (2022). Epidemiology and Risk Factors of Table-Tennis-Related Injuries: Findings from a Scoping Review of the Literature. *Medicina*, *58*. https://api.semanticscholar.org/CorpusID:248368760

Borg, W. R., & Gall, M. D. (1984). Educational research: An introduction. *British Journal of Educational Studies*, *32*(3).

Can, H., Lu, M., & Gan, L. (2011). The research on application of information technology in sports stadiums. *Physics Procedia*, *22*, 604–609.

Courtemanche, R., Popa, D., & Léna, C. (2020). *Exploring Oscillations in Expert Sensorimotor Anticipation: The Tennis Return of Serve*. https://api.semanticscholar.org/CorpusID:219885515

Darajat, J., & Abduljabar, B. (2014). Aplikasi Statistika Dalam Penjas. *Bandung: CV. Bintang Warliartika*.

Ferrández, C., Marsan, T., Poulet, Y., Rouch, P., Thoreux, P., & Sauret, C. (2020). Physiology, biomechanics and injuries in table tennis: A systematic review. *Science & Sports*. https://api.semanticscholar.org/CorpusID:225488243

Fuchs, M., Liu, R.-Z., Lanzoni, I. M., Munivrana, G., Straub, G., Tamaki, S., Yoshida, K., Zhang, H., & Lames, M. (2018). Table tennis match analysis: a review. *Journal of Sports Sciences*, *36*, 2653–2662.

https://api.semanticscholar.org/CorpusID:3909220

Gao, X., Tian, J., Liang, X., & Wang, G. (2014). ARPP: An Augmented Reality 3D ping-pong game system on Android mobile platform. *2014 23rd Wireless and Optical Communication Conference (WOCC)*, 1–6. https://api.semanticscholar.org/CorpusID:26949098

Gumilar, A., Darajat, J., Ma'mun, A., Nuryadi, N., Hambali, B., Mudjihartono, M., & Mulyana, D. (2022). Batting Performance Analisys of West Java Athletes. *Jurnal Pendidikan Jasmani Dan Olahraga*, *6*(2), 176–181. https://doi.org/https://doi.org/10.17509/jpjo.v6i2.37215

Hadi, A. (2018). *Persyaratan Umum Kompetensi Laboratorium Pengujian & Laboratorium Kalibrasi ISO/IEC 17025: 2017*. Gramedia Pustaka Utama.

Hanim, M., & Tomoliyus, T. (2018). Design of Table Tennis Tool for Drive Stroke Drill Training to Beginner. *Proceedings of the 1st International Conference on Science and Technology for an Internet of Things*.

Hashimoto, H., Ozaki, F., & Osuka, K. (1987). Development Of A Pingpong Robot System Using 7 Degrees Of Freedom Direct Drive Arm. *Other Conferences*. https://api.semanticscholar.org/CorpusID:110196837

Huang, L., Ng, J. W. C., & Lee, J. (2023). Nutrition Recommendations for Table Tennis Players—A Narrative Review. *Nutrients*, *15*. https://api.semanticscholar.org/CorpusID:256582289

Hung, H.-C., Shwu-Ching Young, S., & Lin, K.-C. (2018). Exploring the effects of integrating the iPad to improve students' motivation and badminton skills: a WISER model for physical education. *Technology, Pedagogy and Education*, *27*(3), 265–278.

Jun, Z. (2014). *Biomechanical study of different techniques performed by elite athletes in table tennis*. https://api.semanticscholar.org/CorpusID:145034111

Kong, X., & Tanaka, A. (2021). AI Table Tennis: Methods and Challenges. *2021 IEEE 10th Global Conference on Consumer Electronics (GCCE)*, 837–838. https://api.semanticscholar.org/CorpusID:244778579

Liu, C., Hayakawa, Y., & Nakashima, A. (2012). Racket control and its experiments for robot playing table tennis. *2012 IEEE International Conference on Robotics and Biomimetics (ROBIO)*, 241–246. https://api.semanticscholar.org/CorpusID:16026165

Liu, C., Hayakawa, Y., & Nakashima, A. (2013). Racket Control for a Table Tennis Robot to Return a Ball. *SICE Journal of Control, Measurement, and System Integration*, *6*, 259–266. https://api.semanticscholar.org/CorpusID:109764776

Loland, S. (2002). Technology in sport: Three ideal-typical views and their implications. *European Journal of Sport Science*, *2*(1), 1–11.

Ma, H. (2020). Improvement of table tennis technology based on data mining in the environment of wireless sensor networks. *International Journal of Distributed Sensor Networks*, *16*. https://api.semanticscholar.org/CorpusID:225123190

Matthews, W., & Cottrell, L. (2000). The PingER project: active Internet performance monitoring for the HENP community. *IEEE Commun. Mag.*, *38*, 130–136. https://api.semanticscholar.org/CorpusID:62151903

Michalski, S. C., Szpak, A., Saredakis, D., Ross, T. J., Billinghurst, M., & Loetscher, T. (2019). Getting your game on: Using virtual reality to improve real table tennis skills. *PloS One*, *14*(9), e0222351. https://doi.org/10.1371/journal.pone.0222351

Mohnsen, B., McKethan, R. N., & Turner, E. T. (1999). Using Multimedia Programming to Teach Sport Skills. *Journal of Physical Education, Recreation & Dance*, *70*(3), 22–25.

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.

Santosa, T., Setiono, H., & Sulaiman, S. (2017). Developing return board as an aid for forehand topspin in table tennis. *The Journal of Educational Development*, *5*(2), 210–223.

Schmidt, S. L. (2020). How Technologies Impact Sports in the Digital Age. In *21st Century Sports* (pp. 3–14). Springer.

Silverman, S. (1997). Technology and physical education: present, possibilities, and potential problems'. *Quest*, *49*(3), 306–314.

Siregar, S., Faridah, E., & Hasibuan, R. (2023). Applications-Based Learning Media to Improve Students' Table Tennis Basic Skills: Viewing its Effectiveness. *AL-ISHLAH: Jurnal Pendidikan*. https://api.semanticscholar.org/CorpusID:258155508

Stefanyshyn, D. J., & Wannop, J. W. (2015). Biomechanics research and sport equipment development. *Sports Engineering*, *18*(4), 191–202.

Straub, G., & Klein-Soetebier, T. (2017). Analytic and descriptive approaches to systematic match analysis

in table tennis. *German Journal of Exercise and Sport Research*, *47*, 95–102. https://api.semanticscholar.org/CorpusID:114334563

Udomvirojsin, C., & Vongsrangsap, S. (2023). Innovation and Technology in Table Tennis. *ACPES Journal of Physical Education, Sport, and Health (AJPESH)*. https://api.semanticscholar.org/CorpusID:259909255

Wasan, A. (2020). THE INNOVATION OF RETURN BOARD ASSISTANCE FOR BACKHAND AND FOREHAND ON TENNIS TRAINING. *PalArch's Journal of Archaeology of Egypt/Egyptology*, *17*(4), 1–14.

Wong, D. W., Lee, W. C.-C., & Lam, W.-K. (2020). Biomechanics of Table Tennis: A Systematic Scoping Review of Playing Levels and Maneuvers. *Applied Sciences*, *10*, 5203. https://api.semanticscholar.org/CorpusID:222128494

Yamashita, T., & Kobayashi, T. (2018). Smart ping pong racket by ultrathin piezoelectric strain sensor array. *2018 Symposium on Design, Test, Integration & Packaging of MEMS and MOEMS (DTIP)*, 1–3. https://api.semanticscholar.org/CorpusID:49414781

Yudiana, Y., Hidayat, Y., Hambali, B., Gumilar, A., & Mudjihartono. (2021). Volleyball information system for volleyball performance assessment. *International Journal of Human Movement and Sports Sciences*, *9*(4), 94–99. https://doi.org/10.13189/saj.2021.091316