



www.ijemst.net

Effectiveness of Sensor-Based Media to Improve Referee Education

Indra Kasih 

Universitas Negeri Medan, Indonesia

Eva Faridah 


Universitas Negeri Medan, Indonesia

Samsuddin Siregar 

Universitas Negeri Medan, Indonesia

Sabaruddin Yunis Bangun 

Universitas Negeri Medan, Indonesia

Albadi Sinulingga 

Universitas Negeri Medan, Indonesia

To cite this article:

Kasih, I., Faridah, E., Siregar, S., Bangun, S. Y., & Sinulingga, A. (2022). Effectiveness of sensor-based media to improve referee education. *International Journal of Education in Mathematics, Science, and Technology (IJEMST)*, 10(2), 391-408. <https://doi.org/10.46328/ijemst.2248>

The International Journal of Education in Mathematics, Science, and Technology (IJEMST) is a peer-reviewed scholarly online journal. This article may be used for research, teaching, and private study purposes. Authors alone are responsible for the contents of their articles. The journal owns the copyright of the articles. The publisher shall not be liable for any loss, actions, claims, proceedings, demand, or costs or damages whatsoever or howsoever caused arising directly or indirectly in connection with or arising out of the use of the research material. All authors are requested to disclose any actual or potential conflict of interest including any financial, personal or other relationships with other people or organizations regarding the submitted work.



This work is licensed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License.

Effectiveness of Sensor-Based Media to Improve Referee Education

Indra Kasih, Eva Faridah, Samsuddin Siregar, Sabaruddin Yunis Bangun, Albadi Sinulingga

Article Info

Article History

Received:

12 May 2021

Accepted:

09 December 2021

Keywords

Sensor-based media

Volleyball

Referees

Research and

Development (R&D)

Abstract

The purpose of this research is to produce a new product in the form of censorship media and video assistant referee (VAR) in assisting referee leadership in a championship to achieve fair play. This research uses the Research and Development (R&D) method from Sugiyono using ten steps. The place of research was carried out at the All-Indonesian Volleyball Association, Deli Serdang Regency. The population and sample in this study were 36 Deli Serdang Regency volleyball players with a small sample of 6 people, a large sample of 16, and a comparison sample of 14. For the referee sample, six nationally licensed and nine regional licensed referees. The results of this study include Net and VAR sensors used to develop a player error detection tool when smashing and blocking. The results are obtained from the data from expert validation, including: (1) Material experts 92.3% with the "Very Eligible" category. (2) Media Experts 92.5% with the "Very Eligible" category. In large-scale trials on referees and athletes, the resulting percentages were 90.8% and 92.7%, respectively, while in the comparison trial, the percentage produced was 92.5%.

Introduction

The rapid advancement of science and technology cannot be denied that the innovation of various research is growing rapidly (Kaban, 2021; Smaldino, Lowther, & Russell, 2011; Tarman, 2016). The advancement of technological science or science and technology has helped various human activities in various activities (Alharthi & Zhang, 2021; An, 2021; Brigas, 2019; Fernández et al., 2019; Tarman & Dev, 2018), especially for the field of sports has been petrified in the field of training and matches (Ramli, 2021). Sports achievement is a sport that fosters and develops athletes in a planned, tiered, and sustainable manner through competitions to achieve achievements with the support of science and technology (Tangkudung & Wahyuningtyas, 2006).

Volleyballs are games over a rectangular field 9m wide and 18m long, bounded by a 5cm wide line. In the middle is installed a net that is 9.5 m long or as wide as a field stretched strong with a height of 2.43 m from the bottom specifically for men, while for women, the net's height is 2.24 m (Ahmadi, 2007). A referee certainly leads the volleyball game. The order of the match and the regularity of the competition are largely determined by the quality of the referee (Kasih, 2015). Volleyball referees are limited in age so that when it is time or the

age of more than 55 years will inevitably have to retire. A referee is only allowed to be aware of his class. District/city referees are not allowed to referee provincial level matches, then provincial level referees are not allowed to be aware of the national level and as well as possible. The level of volleyball stewards issues the referee's certificate. The District / City PBVSI Board issues the certificate of district/city level referee, and then the provincial level referee the certificate is issued by the Provincial PBVSI Board (Siregar, 2008).

Referees in officiating a match are monitored by the SRC (Special Referee Commission) to assess the performance of referees, linesmen, scores on the field (Bisagno & Morra, 2018). A referee must have a good performance following applicable refereeing rules. Based on field observations, the referees still get many protests from the players and coaches due to controversial decision-making because volleyball matches in Indonesia have not used technology that can help referees in decision making when officiating a match, especially at the district/city level.

Therefore, VAR technology was supported with net sensors to see all errors in front of the net to facilitate referees in making decisions towards professional referees assisted by VAR technology. From the discussion above, researchers developed assistive media with VAR technology tools added with net sensors titled "Development of Media Devices Assists Volley Ball Refereeing towards Fair Play Championship Results and Professional Referees." The study increases the effectiveness and accuracy of referees making decisions in a match. It is an innovation in the form of a video assistant referee (VAR) tool coupled with sensors placed between two nets in volleyball matches that are more effectively used during matches.

- a. For volleyball referees, it is expected from this development to be one of the evaluation materials for referees to improve the quality in officiating a match.
- b. For athletes, increase confidence in the referee to lead his match as fairly as possible

Literature

Research and development methods or, in English, Research and Development, are used to produce a particular product and test the effectiveness (Borg & Gall, 2003). To be able to produce a particular product used by research that is a needs analysis and tests the effectiveness of the product in order to be able to collect in the wider community, research is needed to test the effectiveness of the product, so research and development are longitudinal (gradually can multi-year) (Barisone, 2019). Research and development methods have been widely used in the fields of Natural Sciences and Engineering (Sugiyono, 2016). Almost all technological products include electronic devices, motor vehicles, airplanes, ships, weapons, medicines, medical devices, and others (Wijaya et al., 2020). However, development research can also be used in social sciences such as psychology, sociology, education, and management.

Media is everything that can be used to channel messages that can stimulate the occurrence of a work process (Ramli, 2021; Sanjaya, 2006). Media combines hardware and materials (software) that can be used as messages, people, materials, tools, techniques, and environments (Sumiyati, 2007). Media benefits include: 1) clarifying the presentation of the message, 2) Overcoming the limitations of space, time, and memory, 3) Objects can be

large and small, 4) Movement can be fast/slow, 5) Past events and complex objects, 6) The complex can be large/ narrow, 7) Address the nature of the participants, and 8) creating experiential equations and heterogeneous participant perceptions (Aqib, 2013).

Volleyball play begins with a serve shot made by the right-back player (position 1) from the service area. At first, this service was considered a starting blow but developed into a powerful weapon to attack (Beutelstahl, 2016). Two teams play volleyball, each having six players on a 9-meter field and two pitches separated by a net (Viera & Ferguson, 1989). If the opposing team gets a serve, the opponent gets a number and is entitled to serve. The mistake of playing the ball is to lose the rally to get one number and be entitled to serve (Ahmadi, 2008). "Volleyball is a complex game that is not easy for everyone to do. Because the game of volleyball requires a reliable coordination of motion to do all the movements in the volleyball game" (Kalajas-Tilga et al., 2020).

Based on the expert opinion above, it can be concluded that volleyball is a game consisting of two squads of six players, with the beginning of hitting the ball to be passed over the net in order to get numbers, but each team can play three bounces to return the ball (Viera & Ferguson, 1989). The length of the volleyball field attack line = 3 meters. Volleyball court service area = 3 meters. The width of the line in the volleyball field = 5 meters. Volleyball field area = 162 square meters (18 x 9 meters) (Munasifah, 2009) (see Figure 1).

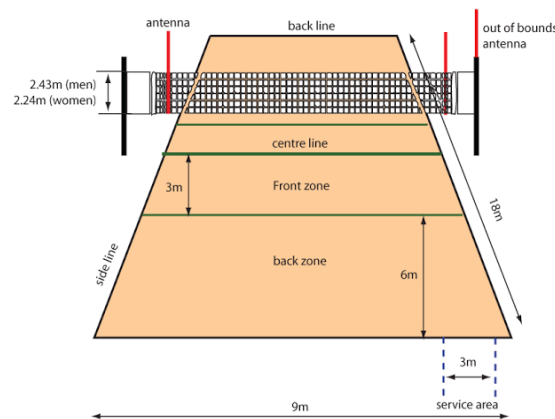


Figure 1. Volley Ball Field

Organizing a volleyball event, organizers must consider various aspects to run successfully, including a qualified referee. The referee is the one who presides over the match from the beginning to the end of the game (Ba, 2005). The referee has the power over his assistants against both competing teams. The presence of referees is needed, especially in official match matches, and it is the referee who is authorized to punish in matches and the applicable rules (Ahmadi, 2007). Another opinion is the understanding that the referee mediates between two teams competing and upholds the rules and norms that exist to create a suitable play match (Sozen, 2012).

Matches are a measuring tool for sports achievement coaching. In particular, in volleyball, success in coaching achievements will be determined by success at a championship or match (Zetou et al., 2008). Volleyball clubs, through their coaches, settle the competition as the target of the coaching process. Before the top of the championship, there were already matches for trials to improve the team (Hakim, 2014). All matches require a

representative referee. In the rule book of the volleyball game (Ba, 2005), a referee in officiating a match must behave as follows:

- 1) Accurate in making decisions.
- 2) Understand why rules are made.
- 3) Be an efficient referee.
- 4) Make the match run smoothly and direct it to the end well.
- 5) Become an educator who applies rules to punish cheating and disrespectful people (Wang et al., 2009).
- 6) Promote the competition in a way, allowing spectacular elements to run smoothly, and athletes can do what is best to entertain the audience.

Volleyball referees have a level or level. The referee's career must be built level by level cannot jump. The referee's career is earned through training and upgrading activities. The level of refereeing is as follows: (1) District Referee, (2) Provincial Referee, (3) National Referee C, B, A, (4) International Candidate Referee, (5) International. To become a district referee, the candidate must undergo training with a load of 50 hours, then the Provincial referee takes 70 hours of training, and to the national level, it takes 110 hours of training. In presiding over a match, the referee must have a leadership and tough nature in facing the masses. This leadership can be achieved only when there is potential and training for development (Zetou et al., 2008). There are 22 hand gestures for referees and flag gestures for linesmen in the volleyball rule. The referee must memorize and apply according to the errors that exist on the field.

For this reason, it takes repeated exercises repeatedly for a long time (Ahmadi, 2007). In the volleyball rule, there are eight chapters. Volleyball refereeing discusses many things, following the rule of the game text file, official volleyball rules approved by the 32nd FIVB congress 2008.

VAR technology itself began to be glimpsed by many people after the technology was used in football events in world cup matches (Wijaya et al., 2020). This technology can indeed be very sophisticated, but one day there may be even more sophisticated developments from this technology (Ramli, 2021). The use of this technology in the world cup matches not only proves that the world's technological developments are indeed fast. VAR technology uses three letters spelling V A and R. V itself is interpreted by an abbreviation of the word Video (Gayathri et al., 2021). The second is A, and A is defined as an abbreviation of the word Assistant. The last is R which is Referee, so the VAR technology is the Video Assistant Referee (Choi & Johnson, 2005). VAR technology itself has often been used in football matches. The word assistant in the middle of the abbreviation is indeed associated with the technology's function in helping referees see and observe the course of a football match through a video. This technology is used to avoid fraud that usually occurs in the field (Riyana, 2007). VAR technology is a system of documentation or video replay. VAR technology itself is installed in various areas of the field. VAR technology results from an innovation made by IFAB or the International Football Association Board, testing it for seven years. The advantages of using VAR are as follows:

- Present more accurate data about a match to minimize miscommunication between the playing team, including the audience.
- Minimize the controversy over the referee's decision, resulting in displeasure about a referee because

some data and facts underlie his decision.

- Eliminate the perception that the referee is cheating because all decisions are taken according to actual conditions.

In a match, the difference in observation often occurs between referees, athletes, and coaches due to several factors: refereeing, athlete position, and coach position. Based on this weakness, a tool will be needed in solving the problem. Then this VAR also has weaknesses such as errors in the video that was aired, although it is claimed that all referees already know VAR well and the system used is sophisticated so it is indicated to harm one of the teams or wrong decision-making due to misjudgment of a video recording a match on the field so it again can be detrimental to one of the teams.

The VAR system focuses not just on an incident but in total the match, so the possibility of making a wrong decision is still very large (see Figure 2). Applying VAR must meet the steps of using VAR, namely: (1) Camera 1 placed on the net pole next to the referee one task from camera one to record events that occur around the net, (2) Camera 2 is placed on pole two at the referee's two tasks from camera two is to record from the opposite angle of camera one and record the events that occur from the opposite spoon, (3) Both cameras will store video that has been recorded and connected to the laptop, TV, and android. When the recording of errors that occur is needed to be replayed, then the recording results will be replayed to help the referee make a decision, (4) Net belugas sensor to read the errors that occurred on the net.



Figure 2. Video Assistant Referee

A sensor or laser is a semiconductor component that can produce coherent radiation seen by the eye in the form of an infrared spectrum when electrified. A net sensor uses the following steps (see Figure 3):

1. The transmitter sensor will be placed on the net pole next to the referee. One sensor will emit light parallel to the net white ribbon to the receiving sensor
2. The receiving sensor will be placed on the net post above the referee two and will receive light from the transmitter sensor
3. What if there is an object that blocks the light of the sensor's light the sensor feeds the sensor detects the presence of one of the players committing a violation that touches the net at that time, the sensor will signal to the referee that there is an error or a net error.

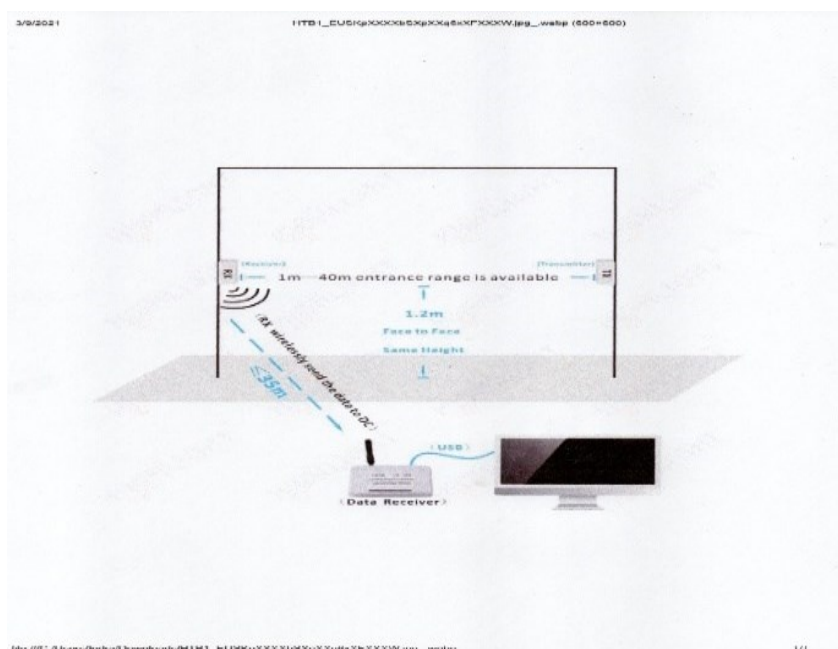


Figure 3. Net Sensor to the Computer

Digitalization in sports has become common (Rosenberg, 2001). The sports of football, tennis, and badminton have used electronic devices to help referees and match devices (Nurani, Sutomo, & Nuryani, 2018). Sensor LDR (Light Dependent Resistor) is one of the components of resistors whose resistance value will vary according to the intensity of light hitting this sensor (Papale & Hooks, 2018). LDR can also be used as a light sensor. The resistance value of this sensor depends heavily on the intensity of light technology (Johnson et al., 2016; Santos et al., 2017). The more light that hits it, the lower the resistance value is. Conversely, if less light hits the sensor (dark), the resistance value will increase so that the flowing electric current will be hampered.

Sporting achievement is a complex action that depends on many other factors, conditions, and influences. Elements of sports are as follows: 1. Skills and techniques (Bahri, Adisasmita, & Asmawi, 2016). 2. Abilities based on practice settings. 3. Adequate behavior for sportsmanship situations. 4. Strategy development. 5. Quality of affective behavior (Furqon, 1995). Sporting achievement is a highly complex activity that depends on many other factors, conditions, and influences. Elements of the sport are as follows: 1. Skills and techniques. 2. Abilities based on practice settings. 3. Adequate behavior for sportsmanship situations. 4. Strategy development. 5. Quality of affective behavior (Sofan, 2013). This research develops media devices to help referee the volleyball towards fair play championship results and professional referees by applying media assist censorship and video assistant referees (VAR) used during volleyball games. This media will help referees bring about a more professional match result (Kirkorian & Anderson, 2008).

Method

The purpose of this research is to produce new products in the form of refereeing media, namely censorship and video assistant referee (VAR), in assisting the leadership of referees in the fight to achieve fair play and professional referees. Researchers use research methods or Research and Development (R&D) (Agustini, Tomi,

& Sudjana, 2017). A development research method is a research method used to produce a particular product and examines the effectiveness of that product. This research method is used to develop a new product or perfect an existing product. Using this development research is expected to help the performance of referees. Researchers will develop products in the form of VAR tool development. The study was titled "Development of error detection tools in performing VAR-based smashes and blocks towards referees." The research place will be conducted at the PBVSI Deli Serdang Provincial Government.

The population is a generalization area consisting of objects or subjects with certain quantities and characteristics determined by the researcher to be studied and then concluded. According to Sugiono (2007), the sample is part of the population. Following the opinion above, the population and sample in this study were the Deliserdang district players totaling 36 people with a small sample of 6 people, a large sample of 16, and a comparison sample of 14 from a sample of 6 nationally licensed referees and nine regionally licensed referees. Data collection in this study was carried out by filling out questionnaires by media experts, material experts, several volleyball referees, and players to get assessments, responses, criticisms, and suggestions (Munasifah, 2009).

This study uses descriptive analysis according to its development (Wang et al., 2009). The initial stage of this development was carried out by making the initial VAR and sensor products, then validated by media experts and materials experts, then the stage I development revision was obtained. The initial product was revised according to input from media experts and materials experts, and then a product that was ready to be tested was obtained. The next stage is a trial with several volleyball referees, and then the final product revision is obtained. The instrument in this development research uses a questionnaire in the form of a statement (Komaruddin, 2016), accompanied by a suggestion column on the next page. The questionnaire was given to media experts, material experts, instrument validators, and PBVSI Deli Serdang referees.

The research design used in this research is development research (Research and Development) called research-based development (Borg & Gall, 2007). Ten steps of design in development research are shown in Figure 4.

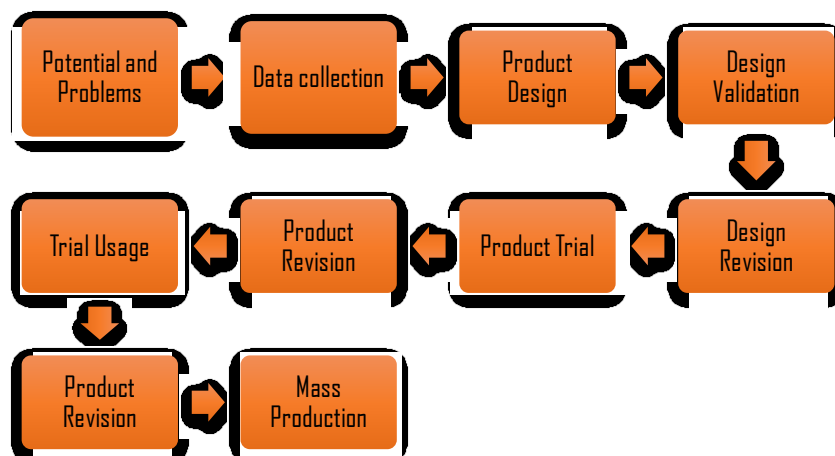


Figure 4. Steps to Use Research and Development Methods (Sugiyono, 2010)

Results and Discussion

The development of player error detection tools when performing smashes and blocks in Volleyball matches based on Net Sensors, and experts in their field validate VAR. Validation is defined as an act of proof appropriately that each material, process, procedure, activity, or mechanism used in production and supervision will always achieve the desired results (Li et al., 2015). Validation also determines the viable and inappropriate products according to the advice given by validators (Cheng, 2021).

It is expected that with this validation, the product results will be optimal by its use. The first test is done after this tool's initial design or design has been observed, corrected, and declared worthy of trial by experts. Evaluation is carried out to improve the product according to the advice and input. The results of testing and evaluation of this development research are given below.

Validation of Materials

Expert material which became a validator in this development research is Amsyah Sijabat S.Pd. He is a nationally licensed referee and is the Referee's Kabid Deliserdang. Researchers chose him as a material expert because his understanding of Volleyball and Volleyball refereeing is adequate. Aspects in material validation include physical, design, and use (see Figure 5).

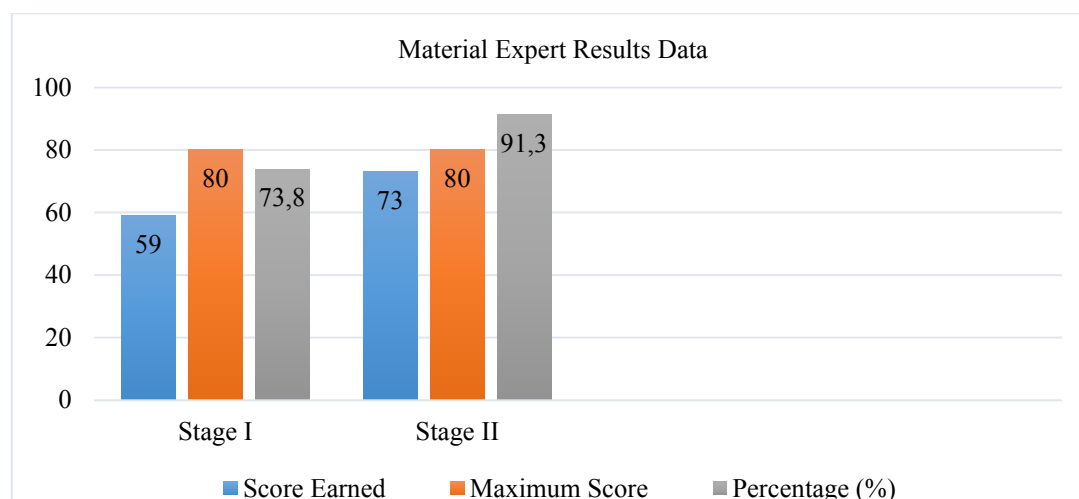


Figure 5. Data Diagram of Material Expert Results

a) Stage I

The data collection of Material Expert stage I was conducted in 2021. Material Experts rated physical aspects 75%, design aspects 75%, and usage aspects 72.5%, with a total score of 73.8% and included in the criteria "Feasible." Moreover, it advises that sensor warning lights be replaced with brighter ones to make it easier for referees in the event of a violation.

b) Stage II

The data collection of the Material Expert phase II was carried out. The Material Expert assessed 90% physical aspects, 90% design aspects, and 92.5% usage aspects with a total score of 91.3% and included in the "Very Eligible" criteria. Furthermore, it gives feedback that the net sensor and VAR can be used without revision.

Media Validation

The media expert who became the validator in this development research was Sigintoro Sibarani A.Md. The researcher chose him as a media expert because his understanding of the programming field is adequate. Aspects in material validation include physical, design, and use (see Figure 6).

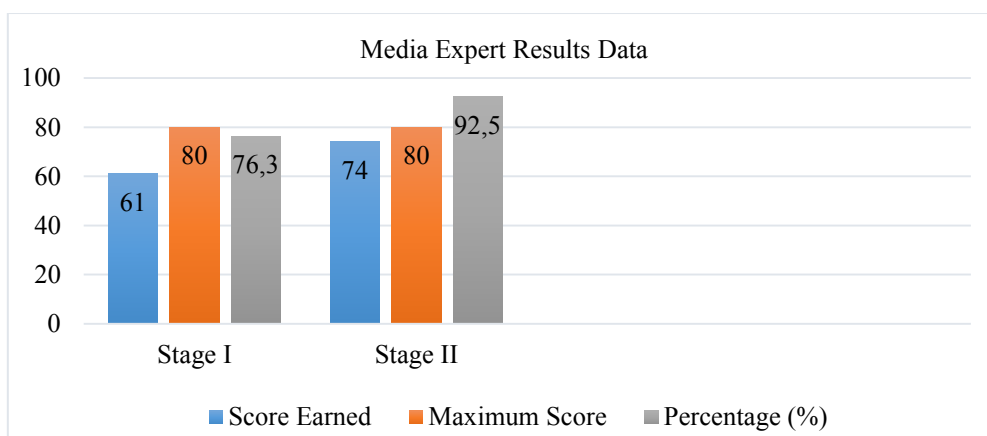


Figure 6. Data Diagram of Media Experts

a. Stage I

The first phase of data collection by Media Experts was carried out in 2021. Media Experts assessed 80% physical aspects, 80% design aspects, and 72.5% usage aspects with a total score of 76.3% and included in the "Eligible" criteria. The validator provides suggestions for making the camera more robust during use.

b. Stage II

Media expert data collection was carried out in 2021. Media Expert assessed 90% physical aspect, 90% design aspect, and the use aspect is 95% with a total score of 92.5% and is included in the "Very Eligible" criteria. Net and VAR sensors can be used without revision. The following is the data from the media validator stage I and stage II, which are concluded in tables and diagrams.

Product Implementation Trial

a) Small Group Trial

The small group trial was held at the Volleyball Field of the PBVSI Deliserdang Regency Government with 12

respondents, including six referees and six athletes. The results of a small group test questionnaire regarding "Development of a Player Error Detecting Tool When Doing Smashes and Blocks in a Volleyball Match Based on Net Sensors and VAR Towards Professional Referees" resulted in scores including: (1) Referee Ratings on Physical Aspects 82%, Design Aspects / Display 81%, and Aspect Usage 80.5% with a total score of 81% with the "Eligible" category. (2) Athletes' assessment on the Physical Aspect is 83.3%, Design/Display Aspect 83.3%, and Usage Aspect 82.2% with a total score of 82.7% in the "Eligible" category. The results obtained can be interpreted that the tool can be tested to the next stage with a slight revision (see Figure 7).

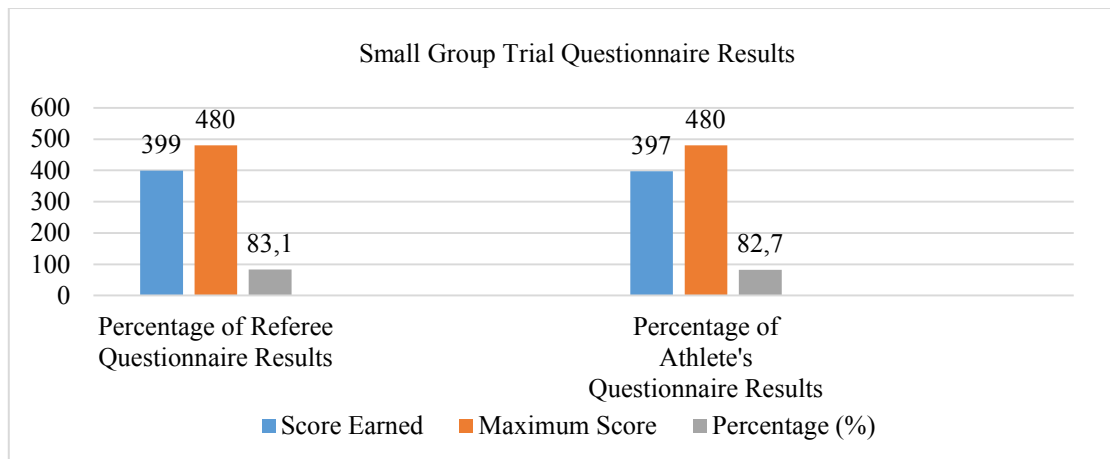


Figure 7. Diagram of Small Group Trial Questionnaire Results

b) Large Group Trial

The large group trial was held at the PBVSI Deliserdang Regency Volleyball Field with 25 respondents, including nine referees and 16 athletes. The trial was carried out in 1 meeting. The following is the large group trial data, which is concluded in tables and diagrams (see Figure 8).

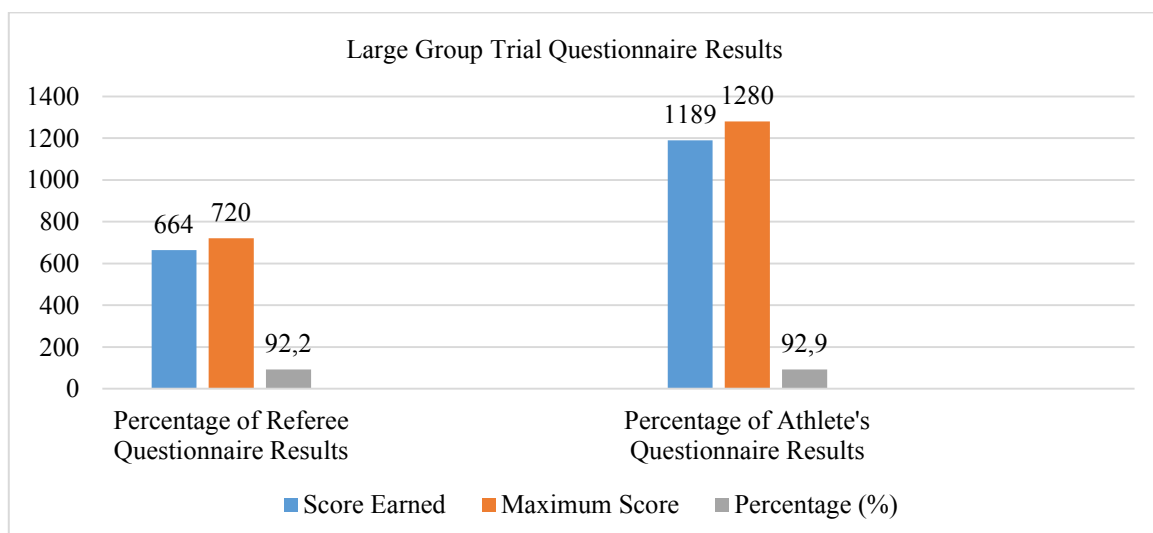


Figure 8. Diagram of Large Group Trial Questionnaire Results

The results of a large group test questionnaire regarding "Development of a Player Error Detecting Tool When Doing Smashes and Blocks in Volleyball Matches Based on Net Sensors and VAR Towards Professional Referees" resulted in scores including: (1) Referee Ratings on Physical Aspects 91.5%, Design/Display Aspect 90.5%, and Usage Aspect 90.5% with a total score of 90.8% in the "Very Eligible" category. (2) Assessment of athletes on the Physical Aspect 92.5%, Design/Display Aspect 93.2%, and Usage Aspect 92.6% with a total score of 92.7% with the category "Very Eligible," which means that the Net Sensor and VAR These are appropriate to be used as a means to assist referees in making decisions as an effort to create professional referees.

c) Comparative Trial

The comparative trial was held with 14 respondents at the Lubuk Pakam Sports Building, Deli Serdang. The trial was carried out in 1 meeting. The following is the large group trial data, which is concluded in tables and diagrams (see Figure 9).

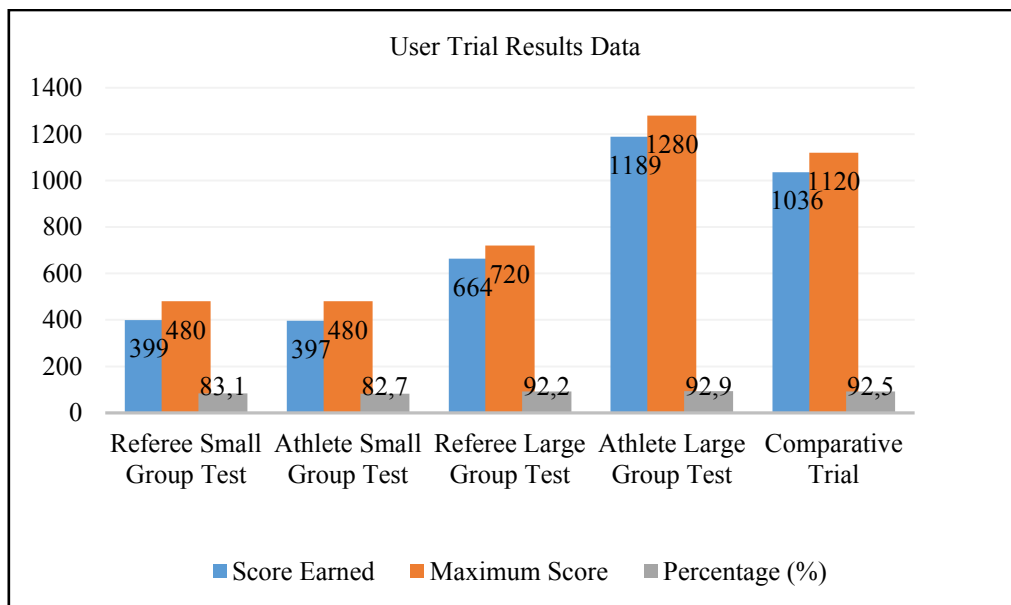


Figure 9. User Test Result Data Diagram

The results of the comparative trial questionnaire regarding "Development of a Player Error Detecting Tool When Doing Smashes and Blocks in Volleyball Matches Based on Net Sensors and VAR Towards Professional Referees" resulted in scores including: (1) Referee Ratings on Physical Aspects 91.8%, Aspects Design/Display 92.9%, and Aspects of Use 92.7% with a total score of 92.5% in the "Very Eligible" category. Thus it can be interpreted that the Net and VAR sensors are appropriate to assist referees in making decisions to realize professional referees.

The development of a player error detection tool when smashing and blocking in a VAR-based volleyball match towards a professional referee is designed and produced into a product in the form of training aids to improve referee performance and assist referees in making decisions in every match. The development process follows

the procedure of research and development (R&D) through planning, production, and evaluation. Then the product is developed with the help of someone who is an expert in technicians. After the initial product is produced, it needs to be evaluated by experts through expert validation and needs to be tested on respondents. The research phase was conducted by evaluating the tools aimed at material experts and media/tool experts, then tested in small groups, continued to the large group trial phase, and finally tested on comparisons. This research and development study aims to develop tools to assist referees in making decisions on every violation in front of the net. The topics for discussion include components. This development used the camera more and added a sensor positioned on the net. The camera and sensor are made into one part with a support that is iron, the footing or pedestal of the product using iron shaped according to the diameter of the volleyball net. This product is also designed not to use cables connected to electricity in its use. This product is designed to use a battery to be easy to transport and can be used in an open environment away from electricity. Usage aspects of using sensor nets and VARs include how to use them and how these floats function when they are used. The developer specializes that this tool can be used during practice and matches to help the referee's performance in overseeing the match and assisting the referee in making decisions so that it is not considered controversial.

The results of the expert validation data show that the product is suitable for use, but with some improvements according to the advice of the expert, including (1) Material Expert: the sensor warning light is replaced with a brighter one to make it easier for the referee in the event of a violation. (2) Media Expert: the camera is made sturdier when in use. From these suggestions, researchers have made improvements according to the direction of expert validation. Implementing the trial research process for small groups, large group trials, and comparison trials went well and smoothly, where data collection was carried out on two different dates, namely Thursday 22 February 2020 and Tuesday 26 February 2020. The sample in this study was (1) PBVSI Deliserdang referee who already has a regional and national level referee license, (2) Volleyball athletes whom PBVSI Deliserdang fosters. The quality of "Development of a Player Error Detecting Tool When Smashing and Blocking in a VAR-Based Volleyball Match towards a Professional Referee" is included in the "Very Eligible" criteria. As well as in the assessment of small group trials, large group trials, and comparison trials. Respondents feel happy and enthusiastic about this product because respondents feel that this product can help the referee's performance, so that every referee's decision that players and officials do not accept can be proven true with this product. The test results can be described in the following discussion:

d) Testing of Material Experts

Testing of material experts is carried out in two stages. The results of the material expert validator as a whole are "Fair," where the results are obtained from the material validator's assessment of the developed tool, seen from the Physical, Design, and Use aspects. The validator assesses that the tool can be used as a medium to help monitor the course of a volleyball match where the camera is positioned to monitor the movement in front of the net from each competing team. Furthermore, the validator provides an assessment that this development is expected to improve the quality and quality of referees in making decisions in every match. Thus the net and VAR sensors that have been developed are suitable for use in supporting and improving the performance of volleyball referees as judges in volleyball matches so that the hope of achieving professional referees can be

realized in the future.

e) Testing for Media Experts

Submission to Media Experts is carried out in two stages. The result of the media validator as a whole is "Decent," where the results are obtained from the media validator's assessment of the developed tool. Judging from the physical aspect, the validator assesses that the physical form of the bag as a whole follows the tools/media commonly used in assisting referees to oversee the match. In the design aspect, the validator assesses that the tool developed has a minimalist form so that it does not interfere with the referee's views in charge of the match. Furthermore, on the aspect of use, the validator provides an assessment that this tool can be used and assists the referee in supervising and assisting the referee in making decisions.

f) Testing of Respondents

The respondent's or user's questionnaire results in the small group test regarding "Development of a Player Error Detecting Tool When Smashing and Blocking in a VAR-Based Volleyball Match towards a Professional Referee" shows that the user's overall rating is categorized as "Decent." These results are seen from several aspects: on the Physical Aspect, researchers saw the response from users who were very enthusiastic about using this tool. The researcher also saw that the user could use the tool according to the specified usage directions. In the Design/Display Aspect, the researcher saw that the user in using this tool was seen without experiencing problems due to the minimalist shape of the tool and did not use cables. Furthermore, researchers saw a good response from users since they first saw this tool on the aspect of use. Users also asked questions about the tools being developed. The results of the assessment above indicate that this tool is feasible to use as a tool to assist referees in supervising and assisting referees in making decisions. However, from this small group trial results, the tool still has shortcomings before being tested in large group trials. The results of the respondents' or users' questionnaires in the large group test regarding "Development of a Player Error Detecting Tool When Smashing and Blocking in a VAR-Based Volleyball Match towards a Professional Referee" indicate that the overall assessment is categorized as "Very Appropriate." These results are seen from several aspects: on the Physical Aspect, researchers saw the response from users who were very enthusiastic about using this tool. The researcher also saw that the user could use the tool according to the specified usage directions. In the Design/Display Aspect, the researcher saw that the user in using this tool was seen without experiencing problems due to the minimalist shape of the tool and did not use cables.

Furthermore, researchers saw a good response from users since they first saw this tool on the aspect of use. Users also asked questions about the tools being developed. The results of the assessment above show that this tool is feasible to use as a tool to assist referees in supervising and assisting referees in making decisions.

The results of the respondent's or user's questionnaire on the Comparison trial regarding "Development of a Player Error Detecting Tool When Smashing and Blocking in a VAR-Based Volleyball Match towards Professional Referees" show that the overall assessment is categorized as "Very Appropriate." These results are seen from several aspects: on the Physical Aspect, researchers saw the response from users who were very

enthusiastic about using this tool. The researcher also saw that the user could use the tool according to the specified usage directions. In the Design/Display Aspect, the researcher saw that the user in using this tool was seen without experiencing problems due to the minimalist shape of the tool and did not use cables. Moreover, on the aspect of use, researchers saw a good response from users since they first saw this tool. Users also asked questions about the tools being developed. The results of the assessment above show that this tool is feasible to use as a tool to assist referees in supervising and assisting referees in making decisions.

Conclusion

Based on the results of the research and discussion that have been described, it can be concluded that:

1. Net and VAR Sensors, which were developed in the Development of Player Error Detecting Devices When Smashing And Blocking in VAR Based Volleyball Matches towards Professional Referees, are suitable to assist referees in monitoring matches and making decisions. This result is obtained from the data from expert validation, including: (1) Material experts 92.3% with the "Very Eligible" category. (2) Media Expert 92.5% with "Very Eligible."
2. Respondents (Users) gave a good response with this Net and VAR Sensor tool to assist the referee in overseeing the match and making decisions. This finding is based on the results of the user questionnaires in small-scale trials on referees and athletes with a percentage of 81% and 82.7%, respectively. In large-scale trials on referees and athletes, the resulting percentages were 90.8% and 92.7%, respectively. While in the comparison trial, the percentage produced is 92.5%.
3. "Development of a Player Error Detecting Tool When Smashing and Blocking in a VAR-Based Volleyball Match Towards a Professional Referee" who is declared "Very Eligible" is based on the last trial conducted on referees and athletes with the following overall assessment: (1) Rating referee on Physical Aspects 91.5%, Design/Display Aspects 90.5%, and Usage Aspects 90.5% with a total score of 90.8% in the "Very Eligible" category. (2) The athlete's assessment on the Physical Aspect is 92.5%, the Design/Display Aspect is 93.2%, and the Usage Aspect is 92.6%, with a total score of 92.7% in the "Very Eligible" category.
4. "Development of a Player Error Detecting Tool When Smashing and Blocking in a VAR-Based Volleyball Match towards a Professional Referee" is also supported by trials on comparison samples to measure the feasibility level of the developed tool. The comparative trial assessment results are as follows: Assessment on Physical Aspects 91.8%, Design/Display Aspects 92.9%, and Usage Aspects 92.7% with a total score of 92.5% in the "Very Eligible" category. Thus, the overall assessment of this product is "Very Eligible" as a medium or means to assist referees in overseeing matches and making decisions.

Recommendations

Based on the results of research and discussion that have been described, it produces recommendations including:

1. The research results on developing a player error detection tool when smashing and blocking in a VAR-

based volleyball match to a professional referee after going through expert tests, small groups, large group tests, and comparisons were feasible and recommended for volleyball matches.

2. This product can also assist referees in supervising matches and making decisions when there is doubt in the referee's leadership.
3. After several tests, this media can be used as an auxiliary medium for volleyball refereeing courses.
4. Researchers who want to develop this product should be investigated further with wider problems.

Acknowledgments

This research is completed according to the schedule given by the LPPM Unimed agency. This research can be useful for researchers and readers in fulfilling scientific references. This study found an auxiliary medium in the match in the form of sensors and VAR in realizing an even better implementation. This assistive media combines the use of sensor technology in connection with a TV or laptop in its implementation so that it will be able to help the referee to identify the mistakes of players touching the net by viewing the recorded results of the game. The expected end of using this media is creating a fair play game and providing satisfaction for players, coaches, and volleyball game lovers. Thank you to the Chancellor of Medan State University and the Medan State University LPPM institution, which has become a research forum on improving scientific writing for lecturers in the field of study.

References

- Agustini, I. P., Tomi, A., & Sudjana, I. N. (2016). Peningkatan Keterampilan Gerak Dasar Lokomotor Menggunakan Metode Bermain Dalam Pembelajaran Pendidikan Jasmani Siswa Kelas III C SDN Krian 3 Kabupaten Sidoarjo. *Jurnal Pendidikan Jasmani*, 26(2), 8–15. <https://doi.org/http://dx.doi.org/10.17977/pj.v26i2.7502.g3422>
- Ahmadi, D. N. (2007). *panduan olahraga bola voli* (Mr.didin (ed.)). Era Pustaka Utama.
- Ahmadi, N. (2008). *Panduan Olahraga Bolavoli*. Era Pustaka.
- Alharthi, M. & Zhang, K. (2021). Faculty's Use of Social Media in Flipped Classrooms: A Mixed-Method Investigation. *International Journal of Technology in Education and Science (IJTES)*, 5(3), 394-410. <https://doi.org/10.46328/ijtes.232>
- Amri Sofan. (2013). *Pengembangan dan Model Pembelajaran dalam Kurikulum 2013*. Prestasi Pustakaraya.
- An, Y. (2021). A History of Instructional Media, Instructional Design, and Theories. *International Journal of Technology in Education (IJTE)*, 4(1), 1-21. <https://doi.org/10.46328/ijte.35>
- Aqib, Z. (2013). *Model model Media dan Strategi Pembelajaran kontekstual*. CV Yrama Widya.
- Ba, L. R. (2005). *Buku Peraturan Bola Voli Yang Resmi*. PP. PBVSI.
- Bahri, S., Adisasmata, Y., & Asmawi, M. (2016). Hasil belajar keterampilan lari cepat. *Cakrawala Pendidikan*, 1(3), 432–442. <https://doi.org/https://doi.org/10.21831/cp.v35i3.11441>
- Beutelstahl, D. (2016). *Belajar Bermain Bola Volley* (Dieter Beutelstahl (ed.)). CV: Pioner Jaya.

- Bisagno, E., & Morra, S. (2018). How do we learn to “kill” in volleyball?: The role of working memory capacity and expertise in volleyball motor learning. *Journal of Experimental Child Psychology*, 167, 128–145. <https://doi.org/10.1016/j.jecp.2017.10.008>
- Borg, W.R. & Gall, M. D. G. (2003). *Educational Research: An Introduction*. Longman, Inc.
- Borg, W.R. & Gall, M. D. G. (2007). *Educational Research: An Introduction, Eighth Edition*. Longman, Inc.
- Brigas, C. (2019). Modeling and Simulation in an Educational Context: Teaching and Learning Sciences. *Research in Social Sciences and Technology*, 4(2), 1-12. <https://doi.org/10.46303/ressat.04.02.1>
- Cheng, J. (2021). Evaluation of physical education teaching based on web embedded system and virtual reality. *Microprocessors and Microsystems*, 83(December 2020), 103980. <https://doi.org/10.1016/j.micpro.2021.103980>
- Choi, H. J., & Johnson, S. D. (2005). The effect of context-based video instruction on learning and motivation in online courses. *The American Journal of Distance Education*, 19(4), 215-227. https://doi.org/10.1207/s15389286ajde1904_3
- Fernández, A., Camargo, C., & Do Nascimento, M. S. (2019). Technologies and environmental education: A beneficial relationship. *Research in Social Sciences and Technology*, 4(2), 13-30. <https://doi.org/10.46303/ressat.04.02.2>
- Furqon, M. (1995). *Teori Umum Latihan* (UNS (ed.)). Maret Press: Universitas Sebelas
- Gayathri, B., Vedavyas, R., Sharanya, P., & Karthik, K. (2021). Effectiveness of reflective learning in skill-based teaching among postgraduate anesthesia students: An outcome-based study using video annotation tool. *Medical Journal Armed Forces India*, 77, S202-S207. <https://doi.org/https://doi.org/10.1016/j.mjafi.2020.12.028>
- Hakim, L. (2014). Method For Improving The Wall Volley Skill Games Stroke In Table Tennis. *Proceeding ISSUES (International Seminar of Sport and. Exercise Science)*, 206.
- Johnson, T. M., Ridgers, N. D., Hulteen, R. M., Mellecker, R. R., & Barnett, L. M. (2016). Does playing a sports active video game improve young children's ball skill competence?. *Journal of science and medicine in sport*, 19(5), 432-436. <https://doi.org/https://doi.org/10.1016/j.jsams.2015.05.002>
- Kaban, A. (2021). Views on the Usage of Social Media Tools in School-Family Communication. *International Journal of Technology in Education (IJTE)*, 4(3), 314-330. <https://doi.org/10.46328/ijte.118>
- Kalajas-Tilga, H., Koka, A., Hein, V., Tilga, H., & Raudsepp, L. (2020). Motivational processes in physical education and objectively measured physical activity among adolescents. *Journal of Sport and Health Science*, 9(5), 462-471. <https://doi.org/10.1016/j.jshs.2019>.
- Kasih, I. (2015). Development of Learning Model Smash Volleyball Based Multiple Training in Faculty of Sport Sciences State University of Medan. *JIPES-Journal of Indonesian Physical Education and Sport*, 1(2), 25-32.
- Kirkorian, H. L., & Anderson, D. R. (2008). *Learning from educational media*. Blackwell Publishing. <https://doi.org/https://doi.org/10.1016/j.appdev.2016.11.007>
- Komaruddin. (2016). *Penilaian Hasil Belajar Pendidikan Jasmani dan Olahraga*. Remaja Rosdakarya.


- Li, J., Chen, X., Huang, Q., Chen, X., Yu, Z., & Duo, Y. (2015). Designation and control of landing points for competitive robotic table tennis. *International Journal of Advanced Robotic Systems*, 12. <https://doi.org/10.5772/60855>
- MichelaBarisone, E. (2019). The effectiveness of web-based learning in supporting the development of nursing students' practical skills during clinical placements: A qualitative study. *Nurse Education in Practice*, 37, 56–61. <https://doi.org/https://doi.org/10.1016/j.nepr.2019.02.009>
- Munasifah. (2009). *Bermain Bola Voli*. Aneka Ilmu.
- Nurani, E., Sutomo, A. D., & Nuryani, N. (2018). Model Deteksi Netting pada Permainan Bola Voli. *JUPITER (Jurnal Pendidikan Teknik Elektro)*, 3(1), 1-6.
- Papale, A. E., & Hooks, B. M. (2018). Circuit changes in motor cortex during motor skill learning. *Neuroscience*, 368(September), 283–297. <https://doi.org/10.1016/j.neuroscience.2017.09.010>
- Ramli, M. (2021). *Media dan Teknologi Pembelajaran*. IAIN: Antasari Press.
- Riyana, C. (2007). *Pedoman Pengembangan Media Video*. Program P3Ai Univeristas Pendidikan Indonesia.
- Rosenberg, M. J. (2001). *E-Learning : Strategies For Delivering Knowledge In The Digital Age*. McGraw-Hill Companies.
- Sanjaya, W. (2006). *Strategi Pembelajaran Aktif*. Kencana Prenada Media Group.
- Santos, D. P., Barbosa, R. N., Vieira, L. H., Santiago, P. R., Zagatto, A. M., & Gomes, M. M. (2017). Training level does not affect auditory perception of the magnitude of ball spin in table tennis. *Journal of Human Kinetics*, 55, 19-27. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5304272/>
- Siregar, S. (2008). *Perbedaan pengaruh metode mengajar dan kemampuan gerak terhadap keterampilan teknik dasar bermain bolavoli* [Universitas Sebelas Maret]. <https://core.ac.uk/download/pdf/16506878.pdf>
- Smaldino, S. E., Lowther, D. L., & Russell, J. D. (2011). *Teknologi Pembelajaran dan media untuk belajar*. Jakarta: Kencana Prenada Media Group.
- Sozen, H. (2012). The Effect of Volleyball Training on the Physical Fitness of High School Students. *Procedia - Social and Behavioral Sciences*, 46, 1455–1460. <https://doi.org/https://doi.org/10.1016/j.sbspro.2012.05.320>
- Sugiono. (2007). *Metode penalitin pendidikan*. Alfabeta.
- Sugiyono. (2016). *Metode Penelitian dan Pengembangan*. CV.Afabeta.
- Sumiyati, A. (2007). *Media Pembelajaran*. Bumi Ranca Ekek Kencana.
- Tangkudung, J. & Wahyuningtyas, P. (2006). *Pelatihan Olahraga “Pembinaan Prestasi Olahraga*. Penerbit Cerdas Jaya.
- Tarman, B. (2016). Innovation and Education. *Research in Social Sciences and Technology*, 1(1). <https://doi.org/10.46303/ressat.01.01.4>
- Tarman, B., & Dev, S. (2018). Editorial: Learning Transformation through Innovation and Sustainability in Educational Practices. *Research in Social Sciences and Technology*, 3(1), i-ii. <https://doi.org/10.46303/ressat.03.01.ed>
- Viera, B. L., & Ferguson, B. J. (1989). *Volleyball. Steps to Success*. Leisure Press: Champaign, IL.
- Wang, A. I., Øfsdahl, T., & Mørch-storstein, O. K. (2009). *Collaborative Learning Through Games – Characteristics*. Model and Taxonomy: Challenges.

Wijaya, T. T., Murni, S., Purnama, A., & Tanuwijaya, H. (2020). Pengembangan media pembelajaran berbasis tpack menggunakan hawgent dynamic mathematics software. *COLLASE (Creative of Learning Students Elementary Education)*, 3(3), 64-72.

Zetou, E., Giatsis, G., Mountaki, F., & Komninakidou, A. (2008). Bodyweight changes and voluntary fluid intakes of beach volleyball players during an official tournament. *Journal of Science and Medicine in Sport*, 11(2), 139–145. <https://doi.org/10.1016/j.jsams.2007.01.005>.

Author Information

Indra Kasih


 <https://orcid.org/0000-0002-9867-1296>

Universitas Negeri Medan

Indonesia

Contact e-mail: indrakasih@unimed.ac.id


Eva Faridah

 <https://orcid.org/0000-0003-0255-0383>

Universitas Negeri Medan

Indonesia


Samsuddin Siregar

 <https://orcid.org/0000-0002-4557-672X>

Universitas Negeri Medan

Indonesia


Sabaruddin Yunis Bangun

 <https://orcid.org/0000-0001-5056-5569>

Universitas Negeri Medan

Indonesia

Albadi Sinulingga

 <https://orcid.org/0000-0001-9405-4699>

Universitas Negeri Medan

Indonesia