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Development of a Ball Return Device for Free Throw Practice in Basketball

Christo Imanuel Kesaulya[1]*, Priyanto[2], Moch Senoadji Karjadi[3]

[123]Physical Coaching Education, Universities Negeri Semarang, Semarang, Indonesia

Keywords

Ball Return; Free Throw; Basketball; Research and Development; PVC Pipe

Abstract

This research developed a modified PVC-based ball return device to optimize self-directed free throw practice in basketball. Using the Research and Development (RnD) method, product feasibility was evaluated through expert validation a dual scale user trail involving Sports Coaching Education students. The expert validation yielded an overall score 540 points (90%), categorizing the device as highly feasible. Structurally, the design and construction aspect scored 86%, while functional capability and safety-durability achieved 91% and 94%, respectively. Empirical testing demonstrated significant quality improvement, with small-scale scores rising consistently across all aspect to reach 80% (design), 82% (function), 83% (safety) in the large-scale trial. Validator suggested adding front netting to catch erratic rebounds and guide a higher parabolic shooting arc. In conclusion, this affordable, portable, tool is highly viable for accelerating shooting repetition and athlete's performance.

✉ Corresponding author :
E-mail: christoimkes@students@unnes.ac.id

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INTRODUCTION

Basketball has transformed into one of the most popular sport, with fans and player increasing rapidly year bay year, including in Indonesia. Basketball involves several fundamental techniques such a dribbling, passing, shooting, and footwork, which athletes must master to achieve optimal performance. According to Jayanti et al., (2025), thorough mastery of basic techniques in is an essential requirement for athletes to adapt to the fast dynamics of the game. According to Novan Adi (in Aryan & Mardela, 2019), basketball is played by two teams of five players each, with the goal of scoring as many points as possible by putting the ball into the opponent's hoop. A team's offensive effectiveness heavily depends on its collective ability to execute basic techniques under game pressure (Hikmah & Siantoto, 2024).

Each basic basketball technique is very important, especially shooting, which is crucial for scoring. Fouls during basketball matches often result in the opposing team being awarded free throw, with each successful shot earning one additional point (Angraini Putri Apifa et al., 2020). A free throw can be compared to a gift given by the opponent (Umniyah et al., 2020). Free throws are important because they allow a team to score point freely without defense. According to Gómez et al., (2020), the success rate of free throws often determines the difference between winning and losing in close games.

According to data from Federation Internatiole de Basketball (FIBA), there are already 450 million basketball practitioners worldwide. At the competitive level, free throw effectiveness often determines the point difference that decides a team's victory or defeat. Gómez et al., (2020) mention that free throws contribute about 20% to 25% of a team's total final score, especially in matches with close score. Shooting is a basic technique that basketball players must master, youmust be able to make shots, because shooting can cover up the weaknesses of other basic techniques(T. A. Wibowo et al., 2023). This highlights that mastery of free throw technique is fundamental aspect that athletes at all levels cannot ignore (Mulianto, 2015).

According to Irham & Kurniawan (2021), ideal free throw practice demands a high volume of repetitions to build consistent muscle memory. Modern coaching trends emphasize efficiency, expecting athletes to make dozens of uninterrupted shots in one training session. According to Irham & Kurniawan, 2021) effectiveness depends heavily on time utilization and the number of repeated movements. However, in practice, athletes often spend more than 50% of training time just retrieving balls that bounce away, reducing training intensity.

Local basketball clubs and educational institutions face limited access to adequate ball return technology. The main challenge is economic-factory made ball return devices tend to be expensive. According to Oktafiranda & Yuliana (n.d.), sports equipment is known to be quite expensive, but in an effort to facilitate sports training, the equipment can be modified using affordable materials, ensuring it does not pose any diffyculties for the practitioner. Budget constraints at schools and amateur clubs often hamper the acquisition of modern and sophisticated training aids, requiring innovative and creative infrastructure solutions. Meanwhile, some unused sport facilities like ball racks have potential to be modified into more functional aids supported by proper and creative designs (Hidayat et al., 2025).

Several studies have explored basketball training aids, but most still have limitations in durability and mobility. That training aids must provide instant feedback without disturbing athletes' natural movement mechanics(Gulo et al., 2025).Meanwhile, national research focuses more on ball return devices made from netting, which often tear easily with prolonged use. Although proven to increase repetitions, material durability and ease of low-cost replication remain unresolved in current literature.

This research identifies gaps in material selections and the upcycling concept of existing facilities (Soimah et al., 2025). There is no specific in-depth study describing the development of ball return device using PVC pipes at an affordable cost. Appropriate technology development in sport should utilize materials easily found in the surrounding environment for board implementation. This gap creates a research opportunity to develop solutions that are mechanically functional, economical, and durable by using existing inventories like ball rack (Mukti et al., 2023).

This study aims to address these limitations by proposing a modified basketball rack integrated with a sliding track made from PVC pipes. Proper use of PVC pipes in the frame provide stability when receiving ball impact, while the pipes offer a smooth surface for the ball to slide back to the player smoothly. According to Wibowo (2023), innovation in sport equipment base on local material contributes to the independence of national sport facilities. The new contribution of this research is the school can produce easily and independently without high cost. Futhermore, this approach can serve a powerful catalyst for creativity, inspiring sports teachers and sports coaches to overcome the limitations of facilities and infrastructure through highly cost-effetive solutions (Muarif et al., 2025).

The main objective of this study is to comprehensively describe the development process and functional effectiveness of the ball return tool by modifying PVC pipes into a training aid. This mechine is an aid for basketball players to practice shooting, with this device shooting practice can be done independently (Hendriko et al., 2019). The research will analyze how the tool's design minimizes ball retrieval time and maximizes free throw repetitions. A descriptive approach will analyze every technical detail to ensure the tool meets training needs. According to O'donoghue (2015), assistive tool design must prioritize ergonomic function to optimal user comfort.

The study theoretically enhances knowledge in sport facility management and appropriate technology. Practically, it offers a solution for coaches and sport facility managers to improve training quality affordably. According to Arif et al. (2021) and Arif (2018) proper facility improvements directly correlate with enhanced athlete performance. This developmen trianing tool coaches to enhance time efficiency durign practice session, maximize training repetition for player to reach peak performance, and ensure optimal utilization (Jayanto et al., 2022). For athletes, this tool is expected to increase training productivity, accelerate muscle memory formation, and ultimately improve shooting success rates in actual competitions.

METHODS

This research uses the Research and Development (RnD) method, focusing on developing and validating a basketball ball return device. According to Sugiyono (2013), this method is used to create a specific product and test its effectiveness. The research aim to transform an PVC pipes for functional training aids. The development model applied is a simplified version of the Borg and gall model, tailored to the researcher's needs. According to Borg and Gall (in Arifin et al., n.d.), the step of development research needs analysis, initial product development, expert validation, and field trail. However, due to time and resource constraints, this research is focused on the design and development stage, expert validation of media/material, and limited-scale functionality testing of the tool.

The research procedure begins with the needs analysis stage and information gathering thru field observations. The researcher identified the main problem, which is the inefficiency of the training time due to manual ball retrieval. The limitations of the training aids in shooting practice can hinder the number of repetitions that athletes should achieve to form perfect muscle memory. Therefore, this initial data serves as the foundation for determining the technical specifications of the tool to be developed. The next stage is the development of the product design, utilizing PVC pipes. PVC pipes have their own unique advantages compare waste materials, they have a consistent trubular structure, ar durable, and are easy to process (Meta Putra et al., 2025). The researcher designed a gravity-based ball return path by calculating the precise slope angle of the inclined plane. The angle of inclination on the inclined greatly determines the coefficient of friction and the ball's rolling speed, making the determination of an inclination angle of 15^0-25^0 crucial for the ball to return precisely to the player.

After the initial design is realized in the form of a prototype, the next step is product validation by experts (expert appraisal). Validation is academics/expert and professional basketball coaches to assess the functionality, safety, and economics of the equipment. According to Sugiyono (2013), expert validation is a crucial step in RnD to ensure that the resulting sports equipment innovation meets technical standards and safe for long-term use by athletes.

Based on input from experts, the researcher revised the product before entering the functional testing phase. The trial was conducted to observe the durability the frame and the smoothness of the track from PVC pipes when subjected to repeated basketball loads. As the explained by Wibowo (2023), the use local materials in sports facility innovations must undergo operational testing to ensure the final product has high durability and economical production cost.

The data analysis technique used is quantitative and qualitative descriptive analysis to process the data from expert (Sugiyono, 2013). The data obtained from validator's assessment sheet of the tool that has been created and developed is converted into a percentage using the descriptive percentage formula (the score obtained divided by the maximum score, multiplied by 100%. The results obtained are then convert into feasibility criteria based on the classification scale presented in **table 1.**

Table 1. feastability criteria based on percentage score

Percentage	Category
81% - 100%	Very Feasible
61% - 80%	Feasible
41% - 60%	Fairly Feasible
21% - 40%	Less Feasible
<20%	**Not Feasible**

The researcher summarizes suggestions and feedback to draw conclusions regarding the product's feasibility. This analysis is in line with the principles of Miles et al., n.d., which state that data in development research must be reduced and presented systematically to serve as a basic for determining whether the product is suitable for use as an effective training medium.

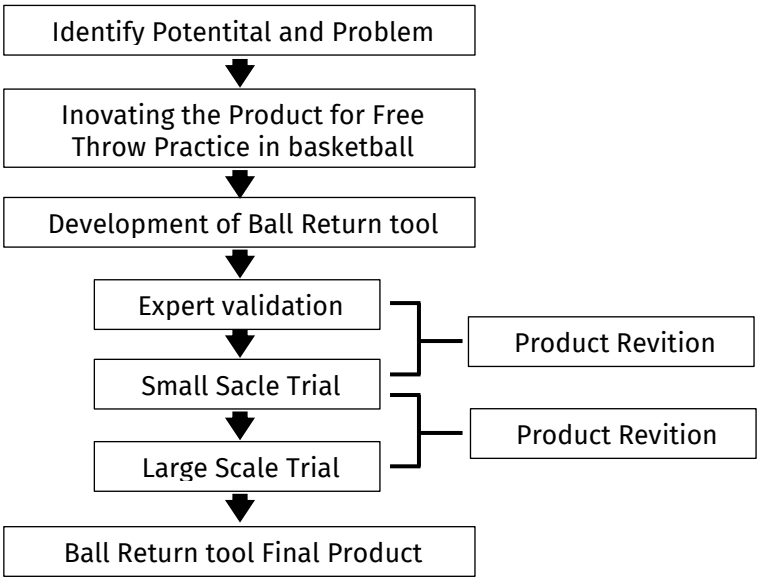

Figure 1. Research flowchart mind map.

RESULTS AND DISCUSSION

In this RnD study, there are several technical stages in implementation of RnD, particularly in the pre-research and post-research phase (Prasetyo, n.d.). This Research and Development (RnD) study aims to produce an innovative product in the form of a ball return training device that utilizes a combination of 1-inch PVC pipes and netting. The primary focus of developing this tool is to enhance the efficiency and effectiveness of shooting practice, specifically free throw, in basketball. Through a well-thought-out design, the device is expected to serve as an economical alternative solution for basketball clubs and educational

institutions that require an automatic ball return system but face budget constraints in purchasing manufactures equipment.

Before entering the product testing phase by experts, this ball return prototype first underwent a needs analysis phase and an initial technical design stage. The assembly process was carried out with high precision to ensure that the 1-inch PVC pipes material used could form a proportional frame according to the standard dimensions of basketball hoop on the court. Once the physical prototype was fully assembled with the ball-catching net, the device was tested independently to observe the ball's drop flow and to evaluate the ease of its assembly a disassembly process.

After the manufacturing phase was completed, the product was then subject to a crucial stage in RnD research, which is the expert judgment validation process. This validation process involved 5 competent expert elements in their respective fields, consisting of 3 academics (sports equipment/media expert lecturers) and 2 coaching practitioner (basketball coaches). The involvement of experts from different background is a vital to ensure that the developed product is evaluated objectively from the perspectives of scientific theory, real-world needs on the court, and mechanical material safety.

This section will describe the results of the testing and analysis regarding the assembly method of the tool, how the tool operates, and the feedback from validators based on the evaluation or validation sheets. The tool validation sheet comprises three aspects, each containing 10 questions: (1) design and construction, (2) functional and feasibility, and (3) durability and safety. There evaluation uses a 4-point scale: (1) disagree, (2) quite agree, (3) agree, (4) highly agree. The validation sheet as shown in the **Table 2.**

Table 2. Validation Sheet

Question	Rating Scale			
	1	2	3	4
Design and Construction Aspect 10 question				
Functional and Feasibility Aspect 10 question				
Safety and Durability Aspect 10 question				

After creating the validation sheet, the next step was to distribute them to the validators. In this study, the researcher involved 5 validators, consisting of 3 academics/experts and 2 basketball coaches. When handing over the validation sheets, the researcher also explained the tool's function, assembly method, manufacturing process, and dimensions. Based on trials with 30 respondends, all 30 instrumen items were declared valid ($r_{calculated} > 0.361$) and reliable (*Cronbach's Alpha* = 0.865), making them feasible for validator assessment.

In general, the date recapitulation from the validation process showed a highly positive response toward the presence of this PVC-based ball return device. The quantitative data obtained from the questionnaires were then processes using qualitative descriptive percentage analysis techniques to determine the final feasibility level of the developed product. The high accumulative percentage reflects the tool is considered successful in solving the limitation of training aids on the court by utilizing affordable local materials.

In detail, the analysis and discussion regarding the quality of this ball return product are divided into three main assessment pillars. The following discussion will thoroughly examine the percentage scores achieved, the interpretation of the feasibility criteria, and the follow-up revisions that have been implemented based on the notes from the experts on each technical aspect of the product.

Overall Result of The Tool Validation

This section will explain the overall result from the validation sheets filled out by academics/experts and basketball coaches. From **Table 2**, contains 30 questions with maximum score of 600 points, calculated using the formula shown in **Figure 2.**

$$\boldsymbol{max\ score = number\ of\ validator \times number\ of\ question \times highest\ score}$$

Figure 2. Formula for Calculating the Total Maximum Score

$$\boldsymbol{P = \frac{\Sigma_x}{\Sigma_{xi}} = 100\%}$$

Legend
P : Eligibility Percentage
Σ_x : Total Score of The Validator
Σ_{xi} : Total Maximum Score

Figure 3. Eligibility Percentage Formula

From **Figure 2**, it can be seen that the maximum score is 600 points. This followed by summing the result from all validator who completed the validation sheets, with a total score of 540 points obtained. Then, the results are entered into the eligibility percentage formula shown in **Figure 3**, resulting in 90%, which according to **Table 1** is classified as very feasible. This actual score obtained was then thoroughly analyzed by comparing it against the maximum ideal total score to measure the extent of conformity between the physical product and theoretical expectations. This date tabulation process was conducted transparently to ensure that every quantitative input from the academics/expert lecturers, basketball coaches, and material expert could be accurately recorded to strengthen the validity of this research data.

Table 3. Percentage of Overall Result Data Validity

Overall Validity Data Result from Experts	540
Percentage	90%

$$\boldsymbol{P = \frac{540}{600} = 100\% = 90\%}$$

Figure 4. Eligibility Percentage Formula for Overall Result Data Validity

The high accumulation of overall score, which reached 90%, is certainly inseparable from the positive ratings spread evenly across almost every aspect in the instrument form. The validators gave high appreciation because they observed an excellent alignment between the frame device, the consistency of the automatic ball return function, safety and durability of the ball return device. Consequently, this ball return device is declared ready to proceed to the next stage, namely small-group to large-group user testing, without requiring major structural framework overhauls.

Although cumulatively this product has been declared highly feasible with a percentage of 90%, researcher still accommodates and respects every note in the form of qualitative criticism provided by the experts for the sake of achieving protection in the final product. The remaining 10% value that was not achieved in this test is viewed as a valuable evaluating space for the researcher to carry out refinement actions, especially on minor details such as the neatness of the net knots, the addition of locking pegs, and increasing time efficiency during the disassembly process of the PVC pipes. Through this comprehensive and the revision-open approach, the final ball return product generated in this chapter is not merely statistically

superior on paper, but this also truly proven to be solution-oriented, safe, and highly functional when implemented in actual basketball practice sessions.

Figure 5. Ball Return Device

Percentage Result for The Design and Construction Aspect

This section discusses the percentage result for the design and construction aspect as assessed by the validator from the validation sheets. The percentage for each aspect is calculated using the same formulas shown in **Figure 2** and **Figure 3**. **Figure 2** is used to determine the maximum score for each aspect, which is 200 points, while **Figure 3** is used to calculate the eligibility percentage for each aspect, resulting in different percentages.

For the design and construction aspect, a score of 172 points was obtained, resulting in a percentage of 86%. This percentage indicates that the tool is highly feasible based on **Table 1** from the perspective of design and construction, with the percentage calculation shown in **Table 4** and **Figure 6.**

Table 4. Percentage of Design and Construction Aspect

Design and Construction Aspect	172
Percentage	86%

$$\boldsymbol{P = \frac{172}{200} = 100\% = 86\%}$$

Figure 6. Eligibility Percentage Formula for Design and Construction Aspect

The validator assessed that using 1-inch PVC pipes as the main material was an appropriate choice. According to (Hazairin, 2024), this size was considered to provide a good balance of structural, strength, and flexibility when assembled, and it was deemed not to damage the vinyl flooring of the court. Additionally, the use of PVC Pipes was seen as significantly reducing costs (Zulharnah et al., 2024).

Percentage Result for The Functionality and Feasibility Aspect

On the aspect of functionality and operational feasibility, this ball return tool received very high ratings from the validators, a score of 181 points was obtained, achieving a percentage score of 91%. With the percentage calculation shown in **Table 5** and **Figure 7.**

Table 5. Percentage of Functionality and Feasibility Aspect

Functional and Feasibility Aspect	181
Percentage	91%

$$P = \frac{181}{200} = 100\% = 91\%$$

Figure 7. Eligibility Percentage Formula for Functionality and Feasibility Aspect

This significant figure places the tool's functionality in the category of "Highly Feasible" based on **Table 1**. This result empirically proves that the developed aid works according to its initial purpose, which is to help increase the repetition of the free throw practice independently.

Expert validators, especially basketball coaches, agreed that the ball return mechanism in the tool works very consistently. The designed net slope successfully utilizes gravitational force maximally, so every time the ball enters the net, it immediately rolls back precisely toward the shooter (Gavali et al., 2022). This consistent ball return is crucial as it help the athletes maintain shooting rhythm and focus without being distracted by chasing stray balls (Bagia et al., 2023).

In terms of time efficiency, the use of this tool had a massive impact during trail training sessions. The time usually spent retrieving ball under the rim can one be reduced by almost 75%. Thus, within the same training duration, an athlete can perform up to three times more shot repetitions compared to conventional training method without ball return aids (Adelina et al., n.d.).

Ease of operation is another plus point that contributed to the high score in this aspect. The installation mechanism is very simple and does not require special mechanical skills, so even beginner athletes can operate it independently before training starts.

This functional feasibility confirms that the PVC pipes and net-based ball return prototype is not just a replica but a solution-supporting tool. The device successfully addresses the challenge of limited coach or training partner assistance on the court by acting as a passive but highly effective "automatic ball return." The 91% result signals that the tool is very ready to be tested on a wider user group.

Percentage Result for The Safety and Durability Aspect

On the aspect of Safety and Durability, which is equally crucial in the development of sports equipment is safety and durability. This ball return tool received very high ratings from the validators a score of 187 points was obtained, achieving a percentage score of 94%. With the percentage calculation shown in **Table 6** and **Figure 8.**

Table 6. Percentage of Safety and Durability Aspect

Safety and durability Aspect	187
Percentage	94%

$$P = \frac{187}{200} = 100\% = 94\%$$

Figure 8. Eligibility Percentage Formula for Safety and Durability Aspect

This high safety rating guarantees that ball return tool is completely safe for athletes of all ages to use and does not pose any new injury risks in the area beneath the basketball hoop. Validator gave high mark because all surface of the 1-inch PVC pipes used were cleaned and finished smoothly, ensuring no sharp edges that could hurt player's hands during installation or use.

Regarding material durability, the tool proved robust after a series of impactg test using a size 7 basketball at standart pressure. According to (Muhammad Syarif et al., n.d.), the combination of elastic PVC pipes and flexible netting absorbs ball impact anergy very

effectively without breaking or shifting the frame strucure. PVC's resistence to water and rust also ensures a long lifespan, even with frequent outdoor exposure(Umari, n.d.).

Experts also rated the safety of the tool's positionsing very highly. The net structure's placement under the hoop is precisely calculated to avoid interfering with athletes' linear movement during landing after jumps. This safe distance is vital to prevent athletes from stepping on the frme base, which could cause ankle injuries.

With a 94% score, safety is durability stand as the strongest pillars of this ball return product. This tool demonstrates that innovation using simple, economical materials like 1-inch PVC pipes does not compromise user safety on the court. The product is declared very safe, durable, and ready for use in intensive basketball training programs.

Small-scale and Large-Scale Trial Result

After this process of validation, the product and the product declared highly feasible by expert validator, next stage was to measure this product is feasibility and practically through direct implementation with students and basketball athletes. This field data collection was conducted in two stages: a small-scale trial and a large-scale trial. The evaluation of student's response focus on same three aspect in **Table 2**. The data recapitulation of the result from both trial stage is shown in **Table 7**.

Table 7. Percentage of Small-scale and Large-scale Trial

Question	Trial Scale	
	Small (%)	Large (%)
Design and Construction Aspect	75	80
Functional and Feasibility Aspect	78	82
Safety and Durability Aspect	79	83

The product testing phase for this basketball return device began with a small-scale trial involving a limited sample size, consisting of 20 students from Sports Coaching Education as a beginners and 15 basketball athletes from AKJ Basketball club as a comparation for the beginners and pro player. According to the recapitulated data presented in **Table 7**, the initial feedback from respondents during this small-scale test provided positive evaluation regarding the prototype. The design and construction aspect achieve a feasible percentage of 75%, followed by the functional and feasibility aspect at 78%, while the safety and durability aspect score the highest at 79%. Overall, this initial empirical data demonstrates that the functional framework of this shooting practice supporting tool is already classified as feasible, although it still required minor refinement before moving forward to a boarder user group in the field.

The next stage is large-scale and based on notes from the first stage, the research proceeds to the large-scale trial phase by expanding the subject to include 57 students from Sports Coaching Education as a beginners and 20 basketball athletes from AKJ Basketball club as a comparation for the beginners and pro player. This significant increase in the number of respondents aimed to test the consistency of the ball return device's performance when implemented in self-directed practice sessions with a much higher repetition intensity. The quantitative data analysis from this large-scale phase showed a highly significant upward leap across all main instrument's components. This increase in the feasibility percentage confirms that the structural improvement made to 1-inch PVC pipes frame and the optimized net successfully met the real expectations and training needs of the court user mere comprehensively.

A comparative analysis of **Table 7** reveals that the highest leap in satisfaction occurred within the functional a feasibility aspect, which rose sharply from an initial 78% in the small-scale to 80% in the large-scale. Concurrently, the design and construction aspect experienced a consistent strengthening, rising from 75% to the final feasibility score of 80%. The peak of the product's quality evaluation was achieved by the safety and durability aspect, which successfully reaches the highest final percentage of 83% after being tested by dozens of participants. Through the accumulated result of these two empirical testing phases, it can be significantly concluded that this modified PVC-based sports tool is proven to be highly

effective, safe, portable, and meets the highest academic feasibility standards for integration into basketball training programs.

CONCLUSION

In conclusion, the developed ball return device is highly feasible as a self-directed free throw practice tool, achieving an impressive overall score of 90%. This success empirically proves that simple affordable materials like 1-inch PVC pipes and netting can be engineered into a high-quality sports innovation that dramatically reduce equpment costs without sacrifing functional quality. The device effectively resolves training facility limitations by providing a stable, accurate, and automatic ball return mechanism. This operational efficiency drastically increases shooting repetitions per session, while its ergonomic frame design simultaneosly guarantees athlet safety and prevent injury risks.

While highly rated, validators suggested adding netting to the front section of the ball catcher tu capture erratic rebounds from the rim and help the athletes optimize their shooting trajectory. Ultimately, this research serve as a foundationa stepping stone for coaches and physical education teachers to optimize basketball training programs. Future researcher is encouraged to build upon this design by exploring lighter alternative materials or integrating automatic tilt-angle adjustment features, ensuring the tool continues to evolve alongside the demands of the modern sports industry.

REFERENCES

Adelina, C., Irawadi, H., Barlian, E., & Mariati, S. (2020). Pengaruh latihan menggunakan alat bantu shotloc terhadap hasil free throw atlet bola basket. *Jurnal Patriot*, *2*(4), 1121–1132. https://doi.org/10.24036/patriot.v2i4.717

Angraini, W. P. A., Ilham, & Iqroni, D. (2020). Profil keterampilan shooting free throw atlet bola basket. *Jurnal Olahraga & Kesehatan Indonesia*, *1*(1), 35–41. https://doi.org/10.55081/joki.v1i1.134

Arif, M. F. (2018). *Analisis tingkat kepuasan layanan fasilitas Gedung Olahraga Lembupeteng Kabupaten Tulungagung Provinsi Jawa Timur*.

Arif, M., Darmawang, & Nahriana. (2021). Pengaruh kompetensi profesional, sarana prasarana dan motivasi berprestasi terhadap kinerja dosen. *Jurnal Pendidikan Teknologi dan Kejuruan*, *24*(1), 45–54. https://doi.org/10.23887/jptk-undiksha.v24i1.31205

Arifin, Z. (2020). *Metodologi penelitian pendidikan: Education research methodology*. PT Remaja Rosdakarya.

Aryan, R. M., & Mardela, R. (2019). Tingkat kemampuan shooting free throw atlet bolabasket. *Jurnal Patriot*, *1*(2), 502–516. https://doi.org/10.24036/patriot.v1i2.502

Gavali, P. B., Patil, S. S., & Ingale, S. M. (2022). Design and fabrication of thrower mechanism for multipurpose ball throwing machine. *Asian Review of Mechanical Engineering*, *11*(2), 1–10. https://doi.org/10.51983/arme-2022.11.2.3436

Gomez, M. Á., Medina, R., Leicht, A. S., Zhang, S., & Vaquera, A. (2020). The performance evolution of match play styles in the Spanish professional basketball league. *Applied Sciences*, *10*(20), Artikel 7056. https://doi.org/10.3390/app10207056

Gulo, T. H. F., Paskah, H. Z., Raymond, J. G., Ginting, H., & Lase, W. A. P. (2025). Systematic literature review: Efektivitas model latihan shooting terhadap akurasi tembakan dalam bola basket. *Journal Physical Health Recreation*, *5*(4), 380–389. https://doi.org/10.55081/jphr.v5i4.2105

Hazairin, R. S. (2024). *Pengujian struktur rangka kuda-kuda berbahan dasar pipa PVC untuk hunian sementara (HUNTARA)*.

Hendriko, Edilla, & Irawan, K. (2019). Pengembangan mesin pelontar dan pengumpul bola basket otomatis. *Jurnal Elektro dan Mesin Terapan*, *5*(2), 11–22. https://doi.org/10.35143/elementer.v5i2.2891

Hidayat, A., Hermawan, I., Permadi, A. A., Sonjaya, A. R., Bara, A., & Annisa, A. P. (2025). Upaya peningkatan minat belajar siswa dalam pembelajaran bola voli melalui media modifikasi bola karet pada Kurikulum Merdeka. *Jurnal Jendela Olahraga*, *10*(1), 12–25. https://doi.org/10.26877/jo.v10i1.17841

Hikmah, S. P. N., & Siantoto, G. (2024). Analisis kemampuan shooting 2 point dan free throw siswa hoops usia 7-9 tahun DBL Academy PTC Surabaya. *JPO: Jurnal Prestasi Olahraga*, *7*(4), 297–302.

Jayanti, N. P. S. P., Hita, I. P. A. D., & Mahotama, I. B. G. J. (2025). Pengaruh latihan berbasis game terhadap penguasaan taktik permainan bola basket pada anak sekolah dasar. *Jurnal Ilmiah Multidisiplin*, *3*(8), 606–611. https://doi.org/10.60126/jim.v3i8.1068

Jayanto, C., Karjadi, M. S., & Permono, P. S. (2022). Pengembangan alat latihan dribble menggunakan media four-way pole pada permainan bola basket. *Unnes Journal of Sport Sciences*, *6*(1), 45–53.

Meta Putra, R., Fussalam, Y. E., & Sella, F. (2025). Pemanfaatan limbah paralon menjadi instrumen musik. *SWARA: Jurnal Antologi Pendidikan Musik*, *5*(3), 41–52. https://doi.org/10.17509/swara.v5i3.73411

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative data analysis: A methods sourcebook* (3rd ed.). SAGE Publications.

Muarif, Salahudin, Nasrullah, Satriawan, R., & Firdaus. (2025). Kreativitas guru dalam mengatasi keterbatasan sarana dan prasarana dalam pembelajaran pendidikan jasmani olahraga dan kesehatan di sekolah dasar. *Jurnal Pendidikan Dasar Nusantara*, *11*(1), 89–101. https://doi.org/10.29407/jpdn.v11i1.23145

Muhammad, S. P., Nurjanah, A. S., Utomo, P. K., Purnama, H., Sari, D. P., Bachtiar, E., Isdyanto, A., Londongsalu, J., Aryadi, A., Herlambang, A. R., Prasetyo, B. E., & Gusty, S. (2023). *Material konstruksi*. Tohar Media.

Mukti, A. C., Prasetya, R. D., & Suminto, S. (2023). Aplikasi limbah ban dalam pada produk skateboard carrier. *Idealog: Ide dan Dialog Desain Indonesia*, *8*(1), 124–132. https://doi.org/10.25124/idealog.v8i1.4660

Mulianto, A. (2015). *Analisis kemampuan shooting free throw dan three point dalam permainan bola basket peserta didik MTS 2 Ponorogo*.

O'Donoghue, P. (2015). *An introduction to performance analysis of sport*. Routledge. https://doi.org/10.4324/9781315816340

Oktafiranda, N. D., & Yuliana, E. (2023). Pembuatan busur paralon sebagai upaya mengembangkan pariwisata olahraga di Desa Bojong Koneng, Bogor. *Prosiding Seminar Nasional Pengabdian Kepada Masyarakat*, *2023*(1), 121–128. http://journal.unj.ac.id/unj/index.php/snppm/article/view/38411

Prasetyo, I. (2012). *Teknik analisis data dalam research and development*. Universitas Negeri Yogyakarta. Academia.edu. https://www.academia.edu/31204941/teknik_analisis_data_R_and_D

Soimah, N., Imelda, D. Q., Budiarti, I. N., Pujiati, N., Sari, K., Dahlia, R., & Santoso, H. (2025). Upcycling fun plastics: Solusi berkelanjutan untuk pengurangan limbah plastik menjadi produk kreatif dan bernilai ekonomis. *ABDINE: Jurnal Pengabdian Masyarakat*, *5*(2), 392–403. https://ejurnal.sttdumai.ac.id/index.php/abdine/article/view/612

Sugiyono. (2013). *Metode penelitian kuantitatif, kualitatif dan R&D*. Alfabeta.

Umari, Z. F. (2022). Menganalisa pondasi rumah rakit dari bambu ke pipa PVC di sekitar Sungai Musi Palembang. *Jurnal Teknik Sipil*, *11*(2), 104–112. https://doi.org/10.36706/jts.v11i2.16411

Umniyah, Z. N., Mulyana, D., & Novian, G. (2020). Pengaruh modifikasi tinggi ring basket terhadap peningkatan teknik tembakan bebas (free-throw shoot) dalam permainan bola basket. *Gladi: Jurnal Ilmu Keolahragaan*, *11*(02), 218–226. https://doi.org/10.21009/gjik.112.12

Wibowo, W. A. (2023). *Pengembangan alat sit and reach box untuk mengukur kelentukan tubuh berbasis digital* [Skripsi, Universitas Nusantara PGRI Kediri]. UNP Kediri Repository. http://repository.unpkdiri.ac.id/8412/

Wibowo, T. A., Ndayisenga, J., & Susanto, R. (2023). Basketball free throw skill level of grade 8 boys of Pius Gombong Junior High School. *JUMORA: Jurnal Moderasi Olahraga*, *3*(2), 190–201. https://doi.org/10.53863/mor.v3i2.923

Zulharnah, Mastutie, F., Yunus, A. I., & Sompa, A. (2024). Mengantisipasi genangan air dengan pemanfaatan paralon bekas sebagai biopori pada perumahan subsidi di Kota Makassar (Studi kasus: Perumahan Nasional Panakukkang). *Jurnal Pengabdian Masyarakat (JPM)*, *4*(6), 550–559. https://doi.org/10.59818/jpm.v4i6.970