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Development of Environmentally Friendly Table Tennis Rackets as an Alternative for School Sports Equipment

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ABSTRACT

This study aims to develop an environmentally friendly table tennis racket made from plastic waste as alternative sports equipment for schools, specifically to address the limitations of physical education learning facilities. The method used is Research and Development (R&D) with the Borg and Gall model through the stages of preliminary study, planning, product creation, trials, revisions, and final product improvements. This study was conducted at SMA Negeri 1 Pamotan involving physical education teachers and students as research subjects. Data were collected using a five-point scale questionnaire from 1–5 given to media experts, subject matter experts, and students in small and large-scale trials. Furthermore, the data were analyzed descriptively quantitatively by calculating the average value to determine the level of product feasibility based on aspects of appearance, strength, comfort, ease of use, and learning benefits. The results showed that the assessment of media experts obtained an average of 4.00 in the good category, while the subject matter experts obtained an average of 4.75 in the very good category. In the trial stage for students, the small scale obtained an average value of 4.86 and the large scale 4.62, both included in the very good category. These results indicate that the developed product has good quality and is acceptable to users in the learning process at school. Based on these results, table tennis rackets made from plastic waste are declared suitable for use as alternative training tools and learning media in schools. In addition to its good function, this product is also educational because it can raise students' awareness of the importance of recycling and environmental care. Thus, this product can be an economical, innovative, effective, and sustainable solution to support table tennis learning in schools.

Introduction

Developing adequate and environmentally friendly table tennis training equipment can be an effective way to address the lack of facilities in schools while supporting sustainable environmental programs (Hasmarita et al., 2025) . One innovation currently being developed is modifying table tennis rackets using plastic waste. Using plastic waste as the main material not only helps reduce the pile of difficult-to-decompose waste but also produces equipment that is inexpensive and easy to manufacture locally (Jenabur et al.,

2024) . Several studies have shown that plastic waste for sports equipment, including table tennis rackets, can produce products that are technically standard and function well. For example, a composite racket design made from wood and plastic waste has the same strength and weight as the appropriate standard, making it suitable for sports (Xu et al., 2022) . Furthermore, used table tennis balls can be processed into useful items, demonstrating the great potential of plastic waste in the world of efficient sports (Ochigue et al., 2025).

By modifying table tennis rackets from plastic waste, schools can provide an environmentally friendly and affordable alternative. This not only reduces equipment costs but also provides valuable lessons for students about recycling and waste management (Royani et al., 2025) . This method helps make schools greener while improving the quality of table tennis learning in the long term. Furthermore, modifying rackets from plastic waste has environmental benefits (Bennett & Alexandridis, 2021) . Plastic waste, which is usually problematic because it is difficult to decompose, can be transformed into useful materials. Therefore, this innovation helps reduce waste around schools and educates students and residents about creative and responsible waste management (Ediputra et al., 2025) .

In terms of cost, using plastic waste to make table tennis rackets is very efficient because the material is waste-free (Erhabor & Reis, 2026) . The manufacturing process is simple and uses recycled materials, resulting in low production costs and the ability to produce large quantities at a low price. This helps schools with limited budgets provide good sports equipment (Royani et al., 2025) .

Essentially, modifying table tennis rackets from plastic waste is an innovative solution that combines the functionality of sports equipment, is cost-effective, and environmentally friendly. It is hoped that this will improve the quality of table tennis instruction in schools while supporting environmentally friendly sustainable education.

Research methods

This research is a research and development (R&D) that focuses on the production of environmentally friendly table tennis racket products as a replacement for school sports equipment. The development approach follows the Borg and Gall model, starting from: (1) Preliminary study and data collection; (2) Product or tool planning; (3) Initial product development; (4) Initial field trials; (5) Revisions based on the results of the initial trials; (6) Main field trials; (7) Revisions based on the main trials; (8) Testing in real conditions; (9) Final product revision; (10) Dissemination and implementation.

The subjects of this study were physical education teachers and students at SMA Negeri 1 Pamotan. The product trial was conducted in two stages: a small-scale trial and a large-scale trial, to measure the product's feasibility and effectiveness.

Data collection was carried out through a questionnaire based on a five-point scale (1–5) ranging from "very poor" to "very good".

Table 1 Product Assessment Criteria

Score	Mark	Category
X > 4 .21	A	Very good
3.40 < X ≤ 4.21	B	Good
2.60 < X ≤ 3.40	C	Adequate
1.79 < X ≤ 2.60	D	Not enough
X ≤ 1.79	E	Very less

This instrument assesses various aspects, such as product appearance, strength and durability, usability, and educational value. Data analysis used quantitative descriptive techniques by calculating the average value using the formula:

$$\bar{X} = \frac{\sum X}{n\ x\ k}$$

Description: $\bar{X}$ is the average value, ∑X is the number of scores, n is the number of respondents and k is the number of assessment items. This calculation refers to Sugiyono (2016). For data analysis, with adjustments $n\ x\ k$because the data comes from the number of respondents multiplied by the number of questionnaire items. Next, the average results are converted into a five-scale feasibility category, namely very good, good, adequate, less, and very less, as a basis for determining the feasibility of the product being developed.

Findings

This study aims to develop an environmentally friendly table tennis racket utilizing plastic waste as an alternative sports equipment in schools. The results showed that the developed product received positive evaluations from experts and students. Validation by media experts obtained an average score of 4.00, categorized as good, while validation by material experts obtained an average score of 4.75, categorized as very good. The findings indicate that the developed product has met the design, construction, and functionality requirements.

The results of the student trials also showed a positive response. The small-scale trial achieved an average score of 4.86, while the large-scale trial achieved an average score of 4.62. Both results fall within the excellent category, indicating that the product can be used effectively in learning activities. Compared to previous research that discussed general modifications to sports equipment, this study specifically produced a table tennis racket made from plastic waste, which also has educational value in raising environmental awareness.

Sub Findings

Based on validation results from media experts, the product's appearance aspect achieved an average score of 4.06 (good category). Meanwhile, the construction and material aspects achieved an average score of 3.80 (also in the good category). Overall, validation by media experts resulted in an average score of 4.00 (good category). Therefore, the developed product is declared effective for use in the learning process.

Table 2 Media Expert Validation Results

NO	Aspects	Question	Score	Means	Category
1	Appearance	15	61	4 .06	Good
2		5	19	3.80	Good

	Construction & materials	20	80	4.00	Good
Means					

Based on validation results from experts in related fields, the product's functionality aspect received an average score of 4.90 (very good category). Meanwhile, the content aspect received an average score of 4.60 (very good category). Overall, validation from experts in related fields resulted in an average score of 4.75 (very good category). Therefore, the developed product is declared effective for use in the learning process.

Table 3 Material Validation Results

NO	Aspects	Question	Score	Means	Category
1	Functionality	10	46	4.90	Very good
2	Contents	10	49	4.60	Very good
Means		20	95	4.75	Very good

Based on the results of a small-scale trial on 10 students, the product's Learning aspect achieved an average score of 4.83 (Very Good category). The Content aspect obtained an average score of 4.90, also included in the Very Good category. Overall, the respondents' scores resulted in an overall average of 4.86 (Very Good category). Thus, this product development is declared feasible and ready for use in learning activities.

Table 4 Results of small-scale survey

NO	Aspects	Question	Score	Means	Category
1	Learning	10	483	4.83	Very good
2	Contents	10	490	4.90	Very good
Means		20	973	4.86	Very good

Based on the results of a small-scale trial on 35 students, the product's learning aspect achieved an average score of 4.62 (Very Good category). The content aspect achieved an average score of 4.62, also included in the Very Good category. The overall score from respondents resulted in an overall average score of 4.62 (Very Good category). Thus, this product development is declared feasible and ready for use in learning activities.

Table 5 Results of large-scale survey

NO	Aspects	Question	Score	Means	Category
1	Learning	10	1,617	4.62	Very good
2	Contents	10	1,618	4.62	Very good
Means		20	3,235	4.62	Very good

Discussion

The research results show that the developed eco-friendly table tennis racket product has a high level of feasibility, both from expert and respondent assessments. Validation from media experts reached an average of 4 (Good category), while validation from related field

experts obtained 4.75 (Very Good category). This proves that the product has met the standards of appearance, construction, and function as a table tennis training tool.
Furthermore, small-scale trials with students yielded an average score of 4.8 (Very Good), and large-scale trials yielded an average score of 4.6 (Excellent). This confirms that the product is not only theoretically valid but also effective and well-received by users in learning.

This high level of feasibility aligns with Sugiyono's (2016) view, which states that R&D products are feasible if they meet the criteria of function, appearance, and usability. This table tennis racket product has passed all three of these aspects, making it suitable as an alternative learning medium.

From a learning perspective, eco-friendly table tennis rackets have been shown to increase student interest and participation in physical education (PJOK). Similar studies have found that modifying sports equipment can boost learning motivation through more engaging and relevant experiences (Sudirman, 2025) . Furthermore, table tennis itself is crucial for developing students' coordination, reflexes, and concentration, and the availability of equipment impacts the quality of instruction.

In terms of innovation, the use of plastic waste as the primary ingredient makes this product cost-effective and environmentally friendly (Prihantini et al., 2025) . This aligns with research showing that recycled materials are effective as affordable and educational learning media (Erhabor & Reis, 2026) . Furthermore, it increases students' environmental awareness, as discussed in a study of school ecoliteracy (Rahmah, 2024).
However, this study has limitations, such as the lack of in-depth long-term durability testing, and the limited scope of the trial from just one school, so generalization of the results requires further research.

In conclusion, the development of this eco-friendly table tennis racket has proven effective, feasible, and rich in educational and economic value. This could be a solution to address the lack of physical education facilities in schools while also supporting environmentally friendly education.

Conclusion

Based on the results of research and discussion, it can be concluded that the development of environmentally friendly table tennis rackets made from plastic waste is declared suitable for use as an alternative training equipment in schools, which is indicated by the results of media expert validation with a good category and material expert validation with a very good category, and supported by the results of small and large scale trials which are both in the very good category so that the product can be used in learning; In addition to fulfilling functional aspects such as strength, comfort, and appearance, this product also has educational value in increasing student awareness about waste utilization and environmental preservation, so that it can be an innovative solution in overcoming the limitations of PJOK learning facilities and infrastructure in schools while supporting more effective and sustainable learning.

Reference

Bennett, E.M., & Alexandridis, P. (2021). Informing the public and educating students about plastic recycling. *Recycling* , *6* (4). https://doi.org/10.3390/recycling6040069

Ediputra, K., Hidayat, A., Zulhendri, Z., & Yusrina, E. (2025). *Increasing Student Awareness of Blood Sugar Levels Through the Program* . *6* (1), 20–23.

Erhabor, N.I., & Reis, G. (2026). Affordable Teaching Materials and Recycling Knowledge and Attitudes of Pre-service Teachers: A Quasi-Experimental Study. *Educational Sciences* , *16* (2), 1–13. https://doi.org/10.3390/educsci16020325

Hasmarita, S., Wirasasmita, R., Hidayat, Y., & Saputra, MY (2025). Elementary School Teacher Workshop: Designing Creative Physical Education Learning with Simple Tools Based on Table Tennis Principles (Focus: Utilization of Recycled/Modified Tools for Tennis Training Simulations). *Aksararaga* , *7* (2), 27–34. https://doi.org/10.37742/aksararaga.v7i2.124%0Ahttps://aksaraga.stkippasundan.ac.id/index.php/aksaraga/article/download/124/134

Jenabur, FN, Fiorin, M., Uweng, M., Irma, MB, & Agung, FN (2024). Central publisher. *Central publisher* , *2* , 2048–2054.

Ochigue, P.C.D., Aguilos, M.A., Lubguban, A.A., & Bacosa, H.P. (2025). Circular Economy Solutions: The Role of Thermoplastic Waste in Materials Innovation. *Sustainability (Switzerland)* , *17* (2), 1–27. https://doi.org/10.3390/su17020764

Prihantini, P., Hendrilia, Y., Abidin, AR, Indrayani, T., Azwar, R., Walid, A., & Yantiningsih, E. (2025). Training on Making Innovative Learning Media from Recycled Materials as an Effort to Increase Teacher and Student Creativity. *TOFEDU: Journal of the Future of Education* , *4* (1), 226–230. https://doi.org/10.61445/tofedu.v4i1.417

Rahmah, B. shoimatur. (2024). *IMPLEMENTATION OF ENVIRONMENTAL CARE ACTIVITIES TO DEVELOP ECOLITERACY SKILLS IN STUDENTS AT STATE MIDDLE SCHOOL 1 JETIS PONOROGO* .

Royani, I., Suriyani, S., & Tjahyaningsih, R. (2025). Utilization of Recycled Materials as Innovative Educational Media to Improve Early Childhood Learning. *International Journal of Education and Computer Studies (IJECS)* , *5* (2), 196–203. https://doi.org/10.35870/ijecs.v5i2.5077

Sudirman, S. (2025). Journal of Sports Education, Coaching, and Health (JOCCA). *Systematic Review of Football Tactics Learning in Physical Education Curriculum* , *6* (1), 325–334.

Xu, W., Wu, Z., Lu, W., Yu, Y., Wang, J., Zhu, Z., & Wang, X. (2022). Investigation of the Cutting Strength of Wood-Plastic Composites Using Response Surface Methodology. *Forests* , *13* (9), 1–11. https://doi.org/10.3390/f13091397