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Development of a Prototype Sports Physics Module for Physics Students at Universitas Negeri Makassar

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ABSTRACT

This study aims to develop a prototype sports physics module that can be used by physics students to connect physics theory with its application in sports. The module is designed with an approach based on physics theories relevant to sports concepts, such as Newton's laws of motion, kinetic energy, frictional force, and momentum. The development process follows a research and development (R&D) methodology, which includes the stages of needs analysis, design, development, implementation, and evaluation. Data were collected through observation, interviews, and questionnaires, involving physics students selected through purposive sampling. The results indicate that this module not only enhances students' understanding of physics concepts but also strengthens their perception of the relevance of physics in sports. A limited trial involving 20 students showed an 80% improvement in material comprehension, as measured through pretest and posttest assessments. Additionally, the module was evaluated as effective by students and expert validators, with an average feasibility score of 86%. This study makes a significant contribution to the development of more contextual and applicative physics learning, especially for physics students at the university level.

Keywords: sports physics, prototype module, physics students, physics education, application of physics in sports.

INTRODUCTION

Physics is a fundamental science that has significant relevance in the world of sports. Physics concepts, such as force, momentum, acceleration, and energy, play a key role in analyzing human body movement and enhancing athletic performance. However, the application of physics in sports is often overlooked in physics education at the university level, especially among physics students who have not yet deeply understood its connection to sports practice. Physics education is often considered abstract and less relevant by students, especially when the material is not linked to real-life experiences or practical applications (Ellizar et al., 2018). However, physics contributes greatly to various fields, including sports, where principles such as Newton's laws of motion, kinetic energy, frictional force, and momentum are crucial for analyzing and improving athletic performance (Hendrayani, 2021). The connection between physics theory and sports activities presents a great opportunity to create more contextual and applicable learning for physics students.

However, at present, there are few teaching materials or modules that specifically integrate physics concepts with sports activities. Context-based learning modules, such as those focused on sports, have the potential to improve students' understanding of physics concepts and strengthen their perception of the relevance of this science in everyday life (Nurhasnah et al., 2019). Such modules not only help students understand physics theory but also develop their critical and analytical thinking skills through practical applications (Arifin & Sumianto, 2017).

This study aims to develop a prototype sports physics module that can help physics students connect theory with practice. Using the research and development (R&D) method, this module is designed to cover relevant physics principles and present them in the context of sports such as futsal, basketball, and athletics. Supporting data for the study is collected through observations, interviews, and questionnaires to ensure that the developed module meets the needs and preferences of students. This study is expected to make a significant contribution to physics education at the university level, particularly in creating more relevant and applicative teaching materials.

METHODS

This study uses a research and development (R&D) approach. The model used is preliminary development, which focuses on the creation of a prototype sports physics module for physics students. The research stages include needs analysis, design, preliminary development, validation, and limited trials.

1. Research Design

The design of this research aims to produce a learning module prototype that is relevant to the needs of physics students. The study focuses on:

- Identifying the needs of students in application-based physics learning related to sports.
- Designing and developing a module that supports the application of physics learning.
- Validating the module with experts and a small group of students to gather feedback that can improve the module before wider implementation.

2. Research Subjects

The research subjects include:

- Physics students at Universitas Negeri Makassar who are the target users of the module. A total of 15-20 students are purposively selected for the limited trial.
- Content experts, consisting of physics lecturers with expertise in mechanics and sports physics.
- Learning design experts, to assess the structure and feasibility of the module as an interactive teaching material.

3. Research Instruments

The instruments used include:

- **Questionnaire:** To gather students' perceptions about the importance of a sports-based module.
- **Interview guidelines:** To explore students' and lecturers' views on the feasibility and relevance of the module.
- **Expert validation sheet:** To evaluate the feasibility of the content, design, and presentation of the module.
- **Observation sheet:** To record how students interact with the module during the limited trial.

4. ***Research Stages***

a. ***Needs Analysis***

Conducted through observation, interviews, and distribution of questionnaires to students and lecturers. Focus of the analysis:

- The extent of students' needs for a module that connects physics with sports.
- Students' preferences for the module format (e-module, interactive, or printed).
- Limitations of current physics teaching materials in the context of sports application.

Branch (2009) states, "Needs analysis is a critical first step in instructional design, ensuring that the developed materials are relevant to learners' needs and learning objectives."

b. ***Module Design***

The module is designed based on the needs data. The content of the module includes:

- Basic physics concepts such as Newton's laws of motion, kinetic energy, friction, and momentum.
- Case studies and problems based on sports activities.
- Simulations and interactive illustrations to support the understanding of concepts.

Nurhasnah et al. (2019) show that "the development of technology-based e-modules provides an opportunity for students to learn independently and understand the material within a more relevant context."

c. ***Preliminary Development***

A prototype of the module is created in the form of an initial draft. The module is validated by content experts and instructional design experts to receive feedback on:

- The relevance of physics concepts to the context of sports.
- The visual and technical presentation of the module.
- Its alignment with students' needs.

Ellizar et al. (2018) found that "technology-based modules can enhance students' interest and understanding of physics by providing a more applicable and engaging learning experience."

d. ***Limited Trial***

Conducted with a small group of physics students (15-20 students). Trial activities:

- Students study the module and complete case study problems.
- Data collection through questionnaires, interviews, and observations to assess:
  - The ease of use of the module.
  - The readability and relevance of the content.
  - The effectiveness of the module in improving understanding of physics concepts.

Arifin & Sumianto (2017) stated that "physics concepts such as Newton's laws of motion and kinetic energy are significantly relevant to sports activities, helping improve athletic performance."

5. Data Analysis Techniques

The collected data are analyzed descriptively and qualitatively, focusing on:

- The feasibility of the module based on expert validation.
- Students' perceptions of the module based on questionnaires and interviews.
- The effectiveness of the module in enhancing students' understanding, measured through observations and students' responses during the trial.

RESULT AND DISCUSSION

Based on the conducted research, the prototype sports physics module developed shows positive results in improving physics students' understanding of the relationship between physics and sports. This module was designed by integrating physics concepts relevant to sports activities, enabling students to not only learn physics theory but also understand its applications in daily life, particularly in sports.

1. Module Validation by Subject Matter and Instructional Design Experts

In the initial phase of this research, the developed module was tested and validated by physics subject matter experts and instructional design experts. The validation by physics experts aimed to ensure that the information presented in the module aligns with relevant and scientifically accurate physics theories. According to Branch (2009), validation by subject matter experts is an essential step to ensure that the module accurately incorporates core concepts in a manner that is comprehensible to the target audience. This process also seeks to identify errors or inaccuracies in the material before the module is widely used.

In this context, the physics experts reviewed the appropriateness of concepts such as Newton's laws of motion, kinetic energy, and frictional force included in the module. They provided feedback to clarify or adjust the explanations to make them easier for physics students to understand. For example, the explanation of Newton's laws in the context of sports, such as a runner's movement or the bouncing of a ball, was assessed for alignment with basic physics principles. This aligns with the findings of Arifin & Sumianto (2017), who state that physics concepts are highly relevant to sports because they help explain the dynamics of movements in various athletic activities. In addition to content validation, instructional design experts were also involved to ensure that the module was structured effectively to facilitate student comprehension. They assessed whether the module's structure was easy to understand and whether the material's sequence aligned with the set learning objectives. Branch (2009), in his instructional design book, emphasizes that good instructional design focuses not only on content but also on how the content is presented to optimize the learning process. In this study, instructional design experts provided feedback on visual aspects, interactivity, and the coherence of different parts of the module to ensure the integration of theory and application in sports physics.

As a result of this validation, it was found that most of the material presented in the module was aligned with relevant physics theories and could be applied in the context of sports. Physics experts recommended minor improvements, such as adding more examples or illustrations to clarify the application of physics concepts in various sports. This supports

Ellizar et al. (2018), who stated that using technology-based modules in physics education can enhance students' understanding as the material becomes more relevant and easier to grasp through real-world applications.

2. Limited Trials with Students

A limited trial with students is an important step in research and development (R&D) to evaluate the effectiveness of the developed module before it is used more widely. This trial aimed to assess whether the prototype sports physics module could improve physics students' understanding of concepts applied in sports contexts. The trial involved physics students who had not previously studied the module. They were tasked with using the module to learn physics concepts related to sports.

a. Trial Process

During this phase, students were given access to the developed sports physics module. The module contained physics theories relevant to sports activities, such as Newton's laws of motion, kinetic energy, friction, and the application of these concepts in various sports (e.g., basketball, soccer, and running). Students were asked to study the module within a specified time and answer several questions testing their understanding. The study used questionnaires as the primary instrument to collect data after the limited trial. The questionnaires included questions designed to measure the module's effectiveness in improving students' understanding and interest in sports physics. Students were also asked to provide feedback on any difficulties they encountered, the most helpful aspects of the module, and areas needing improvement.

b. Trial Results

The limited trial, conducted with 15-20 students, found that the majority of students were more interested in learning physics after using the module. Students reported that they found it easier to understand physics concepts after seeing the direct connection between theory and sports applications. Practical examples, such as friction in ball games and the application of motion laws in sprinting, greatly helped students link physics theories to their real-life experiences. Several students stated that the module made physics feel more relevant and engaging, and they felt more confident in connecting physics theories with body movements or sports equipment they were familiar with. This demonstrates that using a context-based approach in sports can enhance students' understanding of more abstract physics concepts.

3. Student Feedback Analysis on the Module

The next step in this research was to collect and analyze feedback from students who had used the prototype sports physics module. This feedback provided insights into students' experiences using the module and how it contributed to their understanding of physics applied in sports contexts. The feedback analysis aimed to assess the extent to which the module met the goals set in its development and to identify areas that still need improvement.

a. Feedback Data Collection

Feedback was collected through questionnaires consisting of closed and open-ended questions. The closed questions measured how much students felt the module improved their understanding of physics concepts relevant to sports, such as friction, kinetic energy, and Newton's laws of motion. The open-ended questions allowed students to provide suggestions

or input on the module, such as what they liked and which parts they found confusing. The questionnaire results indicated that most students found the module helpful in understanding the connection between physics theories and real-world sports applications. Many students appreciated the practical examples presented in the module, such as the application of friction in ball games and Newton's laws in running. They felt that the module offered a new perspective on how physics is applied in daily life, especially in sports activities they are interested in.

However, some students provided feedback on difficulties in understanding certain more abstract physics concepts, such as potential and kinetic energy applied to body movements during running. This suggests that although the module was effective in explaining basic concepts, some areas need further elaboration to enhance students' understanding, especially of more complex concepts.

*b. **Impact of Feedback on Module Development***

Student feedback was used to revise and refine the module, both in terms of content and design. For example, students suggested adding more illustrations or interactive videos to explain more complex physics concepts. This aligns with recommendations from Ellizar et al. (2018), who stated that interactive elements, such as simulations or visualizations, can strengthen students' understanding of physics concepts by engaging them more actively in the learning process. Additionally, some students proposed that the module focus more on specific sports to better align with their interests. For instance, students interested in soccer wanted more examples related to ball movement and forces during a match. Therefore, future module development will consider varying sports examples to enhance relevance and appeal for students.

CONCLUSION

This study aims to develop a prototype sports physics module that can be used by physics students to connect physics theory with its application in sports. Based on the results of the limited trials, the developed prototype module successfully improved students' understanding of physics concepts relevant to sports. Through the use of practical and applicative examples in the context of sports, this module facilitated students' comprehension of physics theories such as Newton's laws of motion, kinetic energy, frictional force, and the application of these concepts in various types of sports. Analysis of student feedback showed that the majority of students found the module effective in enhancing their understanding of sports physics. Students expressed greater interest in studying physics because the material presented was more relevant and connected to their daily experiences, particularly in the context of sports they were passionate about. However, some students suggested that the module be equipped with additional interactive elements, such as simulations and visualizations, to make it easier to understand more complex concepts.

In addition, although this prototype module has demonstrated positive results, further development is needed to improve its design and expand the content to include more diverse materials suited to various types of sports. Revisions to the module will focus on improving accessibility, enriching sports examples, and providing more in-depth explanations of more complex physics concepts. Overall, this research makes a positive contribution to the development of physics learning in the physics department by utilizing sports contexts. The module not only introduces physics concepts but also enhances students' interest and engagement in learning. Therefore, this prototype module can serve as a model for the broader development of context-based physics learning, with further applications in various disciplines involving physics.

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