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DEVELOPMENT OF ANDROID APPLICATION "AKUATIKABIOMEK" FOR LEARNING AQUATIC SPORTS BIOMECHANICS

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Abstract
This research aims to develop the Android application AaquaikaBiomek as a digital learning medium to support the biomechanics analysis of water sports movement. Development is carried out using the 4D model or Four-D Model proposed by Thiagarajan which consists of the define, design, develop, and disseminate stages. The application is designed to facilitate Physical Education students in learning the principles of water biomechanics through video-based motion analysis features, motion phase simulations, and interactive learning modules. The research uses a Research & Development approach by involving expert validators, lecturers, and students. The sample consisted of 131 students who took water courses. The instruments include user needs analysis, expert validation sheets, and system usability scale (SUS) questionnaires. The results showed that the AaquaikaBiomek application obtained a content validity score of 95.83% and media validity of 93.75%, both of which are categorized as very feasible. User feasibility testing through a usability assessment resulted in a score of 87.01, which indicates that the app is easy to use, engaging, and useful in the learning process. Thus, the AquaticBiomek application is declared valid, practical, and feasible to be used as a learning medium for aquatic sports biomechanics, both in face-to-face, hybrid, and independent learning.

Keywords: *Aquaculture; Digital Learning Media; Aquatic Biomechanics.*

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INTRODUCTION

Biomechanics of water sports is a branch of science that studies the principles of the mechanics of human movements when in a water environment. In sports such as swimming, diving, water polo, and jumping, an understanding of thrust, water resistance, body position, and movement efficiency is essential to achieve optimal performance (Arisman & Noviarini, 2021). Physical Education students are required to be able to understand the concept, both in terms of theory and its application to movement techniques.

However, the process of learning aquatic biomechanics in college faces several challenges. The results of the learning evaluation show that students still

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have difficulty in understanding the concept of biomechanics in depth, especially when visualizing the relationship between the principles of water mechanics and water sports movements. Biomechanics materials that are abstract and technical often require supporting media such as illustrations, simulations, or systematic visual explanations to be easy to understand. In addition, not all students have access to computer-based motion analysis devices or software commonly used in biomechanics practicums, so learning tends to rely on verbal explanations or hands-on demonstrations.

The development of digital technology and mobile devices provides new opportunities in the development of more practical and accessible learning media (Casey, 2017). The Android app can serve as an interactive learning resource, providing structured materials, simulations of biomechanics concepts, movement phase animation, as well as examples of the application of mechanics principles in water sports. With media that is presented visually, concisely, and easily accessible through students' smartphones, the learning process is expected to be more interesting, easy to understand, and can be done independently or in hybrid learning.

Another benefit of Android-based learning media is that the use of android-based learning media provides a new passion for learning, increasing a person's sense of pleasure and interest during the learning process so as to foster interest and motivation in learning activities (Ahmad, 2014). In addition, Android-based learning media can be developed according to the needs of students, so that the benefits of the learning media developed can be directly felt by students, this is inseparable from the increasingly intensive use of smartphones among students.

Based on these needs, the AaquaikaBiomek Android Application was developed as a learning medium for aquatic sports biomechanics. This application is not intended to measure motion directly using a camera, but functions as a digital-based learning tool that contains aquatic biomechanics material, illustrations of basic concepts, simulations of swimming motion phases, examples of the application of water mechanics principles, and manual analysis guides that students

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can do using other supporting devices. Thus, this application acts as a learning support medium that combines biomechanical theory with visualization and simulation of motion in the context of water sports.

To ensure that the application is developed systematically and according to the needs of the user, this study uses the 4D model or Four-D Model proposed by Thiagarajan. This model includes the stages of define, design, develop, and disseminate. Through this approach, it is hoped that the AaquaikaBiomek application can be a valid, practical, and effective learning medium in supporting students' understanding of the biomechanics of water sports.

Biomechanics of water sports is a field of science that studies how the human body moves and interacts with fluids, especially water, by applying the principles of mechanics, physics, and anatomy. (Hall, 2018) Explains that biomechanical analysis provides a scientific basis for how force works on the body so that it produces efficient movement. In water sports such as swimming, diving, water polo, and jumping, understanding biomechanics is very important because the athlete's body must overcome water resistance, maximize thrust, and maintain a streamlined body position. (Sanders, 2015) emphasized that the water environment poses its own challenges compared to motion in the air due to drag, buoyancy, and fluid resistance that affect movement patterns. Students' understanding of these principles often requires strong visualization in order to see the relationship between mechanical theory and movement techniques in real terms. This is reinforced by (Sanders & Psycharakis, 2018) which states that learning biomechanics becomes more effective when supported by visual materials such as diagrams, simulations, and illustrations of the phases of swimming movement. (Puel, 2020) Through a systematic review, it was also found that visual feedback is an effective medium to help students understand body position, force direction, and technique errors in water sports.

Along with the development of digital technology, mobile learning-based learning media is increasingly relevant to support the biomechanics learning

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process. (Kearney, 2012) mentioning that mobile devices provide learning flexibility because they allow learners to access materials anytime and anywhere. Digital media also provides space for the visual presentation of biomechanics materials through animations, infographics, motion simulations, or videos that are easy for students to understand. Meta-analysis conducted (Sung et al., 2016) It shows that the use of mobile applications has been shown to improve learning outcomes, engagement, and concept retention in various subjects, including science and sports learning. The findings are in line with (Casey, 2017) which explains that digital technology allows physical education learning to be more interactive, especially through motion visualization that was previously difficult to present manually. In the context of biomechanics, digital visualization plays an important role in helping students understand the principles of force, angle of motion, and movement of body segments without having to use high-tech motion analysis tools. This is reinforced by research (Kretschmann, 2015) which shows that visual-based learning is able to significantly improve the understanding of biomechanics compared to conventional learning. (Kwon et al., 2019) It also adds that the use of visual media can improve biomechanical analysis capabilities even in the absence of direct motion measurements.

The development of digital learning media such as Android applications needs to be carried out with a systematic and structured approach, one of which is using a 4D model or Four-D. The model developed by Thiagarajan places the user as the center of learning design, so that each product developed is completely in accordance with the characteristics and needs of the user. The initial stage is defines It aims to identify learning needs, problems faced by users, and the context of media use through needs analysis and literature studies. This stage is very important because it determines the direction and main needs of the product to be developed, as explained by (Sugiyono, 2019) that needs analysis is the main basis in the development of learning media.

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Design is the process of designing the initial form of an application, which includes the design of the interface display, application navigation, material selection, storyboard creation, and determination of content presentation format. The next stage is Develop, which includes the process of prototyping the AquaticBiomek application, the integration of aquatic biomechanics materials, the illustration of the phase of the swim motion, and expert validation to assess the feasibility of content and media design. The expert validation process is an important part of ensuring that the application meets pedagogical, visual, and technical standards before being tested on students, as affirmed by the (Prastowo, 2020) in the study of the development of digital learning media.

The last stage is Disseminate, where applications are disseminated through large group trials, internal publications, and implementation in aquatic learning. This stage not only serves to introduce the application to the user, but also ensures the sustainability of the application's use in the wider learning environment. A number of studies such as (Huang & Chiu, 2015)(Wijaya et al., 2020) shows that 4D models are an effective approach in the development of digital learning media because they emphasize iterative, collaborative, and needs-based processes of users. Therefore, the application of this method in the development of aquatic sports biomechanics learning applications is relevant so that the resulting products are not only materially valid, but also practical and useful for students.

METHOD

The last stage is Disseminate, which is the stage of spreading and implementing the AkuatikaBiomek application to users on a wider scale. At this stage, the application is socialized to lecturers and students of the Physical Education Study Program, and is used in water lectures as a supporting learning medium. In addition, the results of the research and applications developed are published in academic forums and research to encourage the use of digital media in the learning of sports biomechanics. The disseminate stage also includes final improvements to the application based on user feedback so that the application can be used continuously in learning.

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Overall, this research method with a 4D model provides a structured framework in developing AaquaticBiomek learning applications, starting from identifying learning needs, designing and creating media, expert validation, practicality and effectiveness tests, to product deployment to ensure that its application is feasible and useful in learning aquatic sports biomechanics.

This research uses a Research and Development (R&D) approach with reference to the Four-D (4D Model) development model proposed by Thiagarajan. This model was chosen because it is in accordance with the needs of user-oriented digital learning media development, and allows the development process to take place gradually through need exploration, product design, and systematic evaluation. The research was carried out in the Physical Education Study Program, Lambung Mangkurat University on students who took courses related to water sports. The research period lasts for one academic year, including the process of identifying needs, developing prototypes of the AquaticBiomek application, to the stage of testing the practicality and effectiveness of the user.

The subjects in this study consist of students who take water courses, with a total of 131 people. The sample selection uses the cluster random sampling technique, which is a random selection of classes based on the available batch groups and learning classes. In addition to students, this research also involves validators consisting of biomechanics material experts, learning media experts, educational technologists, and programming experts. The involvement of validators aims to ensure the feasibility of the content, appearance, and pedagogical suitability of the developed application.

The research procedure starts from the definition stage. At this stage, a needs analysis is carried out through the distribution of questionnaires and interviews with students and lecturers teaching water sports courses. The second stage is Design, which is the process of designing learning media in the form of the AkuatikaBiomek Android application. At this stage, the design of the content and structure of the application is prepared, including the determination of the material to be displayed,

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motion illustrations, navigation schemes, user interface design (UI/UX), and the overall storyboard of the application.

The next stage is develop, which includes the process of developing the AquaikaBiomek application based on the initial design and testing through an expert validation process. The validators provided an assessment of the aspects of appearance, material feasibility, content readability, pedagogical suitability, and application functionality. Suggestions from experts are used to make improvements before the app is tested to users. The last stage is disseminate, which is the stage of dissemination and implementation of the AaquaikaBiomek application to users. This stage includes field trials that aim to evaluate the feasibility of the applicators.

The instruments used in this study included a needs analysis questionnaire, an expert validation sheet, and a system usability scale (SUS) questionnaire containing 10 questions. The results are used to ensure that the AaquaikaBiomek application is not only feasible to use as a learning medium, but also practical and has a real impact on improving student understanding.

RESULTS

The results of the research conducted using the 4D development model produced several important findings that illustrate the entire development process of the AquaticBiomek application as a learning medium for aquatic sports biomechanics. The first findings were obtained from the definition stage, which is the result of user needs analysis. Needs analysis is carried out at the define stage to identify students' needs for aquatic biomechanics learning media. The instrument consisted of 18 statements with a Likert scale of 1-4 and involved 10 respondents as an illustrative sample.

Table 1. Results of needs analysis

Indicator	Average Score	Interpretation
Visual media needs	3.6	Height
Readiness to use digital media	3.7	Height
Mobile app needs	3.75	High–Very High
Learning barriers faced	3.5	Height

Based on questionnaires given to students and interviews with lecturers, it was found that most students still have difficulties in understanding abstract

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concepts of aquatic biomechanics. The results of the analysis show that students have a high need for digital learning media that is able to support the understanding of water biomechanics concepts. The average needs analysis score reached 3.65 or equivalent to 91.25%, which is in the very high category. Meanwhile, the lecturer who teaches the course stated that aquatic biomechanics material requires media that is able to present illustrations, diagrams, and simulations so that the learning process is more interesting and easy to understand. These preliminary findings show that there is a real need for digital learning media that is visual, systematic, and easily accessible, thus supporting the development of the AkuatikaBiomek application.

The Design Stage produced the initial design of the AaquaikaBiomek application which includes menu structure, navigation flow, learning content, interface display, and visual format of the material. The design was prepared based on the results of a needs analysis and literature review of aquatic sports biomechanics. Apps are created using khodular.io so that they generate apps with APK extensions. The application is designed to have several main components, namely a menu of water biomechanics materials, an illustrative simulation of swimming motion phases, a summary of the concepts of resistance and thrust in water, and an evaluation menu to help students measure their understanding. The flow chart of the AaquaikaBiomek application can be seen in the Figure.

Figure 1. Flow chart of AquaticBiomek application acivity

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The Develop stage produces an initial product of the AaquaikaBiomek application that has been integrated with learning materials and visual illustrations. This initial product was then validated by experts consisting of biomechanical material experts and learning media experts. The validation results can be seen in Table 2 and Table 3.

Table 2. Content validation results

Full Indicator Name	Total Score	Maximum	Percentage
Suitability of Aquatic Biomechanics Materials	19	20	95%
Depth and Breadth of Material	14	16	87,5%
Accuracy of Illustrations and Visualizations	12	12	100%
Language	11	12	91,67%
Compatibility with Users	12	12	100%

Table 3. Media validation results

Indicator	Total Score	Maximum	Percentage	Categories
Display & UI	15	16	93.75%	Excellent
Navigation & UX	14	16	87.5%	Excellent
Quality Features	14	16	87.5%	Excellent
Technical Aspects	15	16	93.75%	Excellent
Learning	15	16	93.75%	Excellent

The validation results showed that the level of validity of the suitability of the materials and illustrations used in the developed media showed an excellent value with a score of 95.83%. Media expert validators by giving a score of 93.75% and are included in the very good category. However, the validator still provided some important input, such as fixing some malfunctioning navigation buttons, resizing and changing the color of the icons to improve readability.

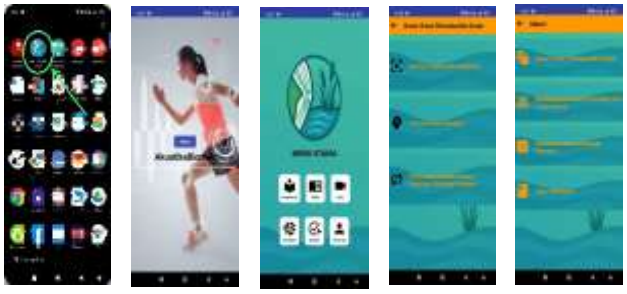

Figure 2. App appearance and features

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At the Disseminate stage, the AkuatikaBiomek application began to be implemented to users. The socialization was carried out through a field trial in a water lecture involving 131 students. User assessment was carried out to determine the feasibility of the AaquaikaBiomek application by filling out a usability questionnaire with results showing an average score of 87.01 with a score range between 67–100. The value falls into the Excellent category, which indicates that the application of AaquaikaBiomek has a very high level of saturation. Most of the respondents (35.9%) were in the score range of 90–100, so the app was rated according to the needs of the user.

Table 4. Summary of System Usability Scale (SUS) Results of AquaticBiomek Application

Statistics	Value
Number of respondents (N)	131
Minimum SUS score	67
Maximum SUS score	100
Average (Mean)	87.01
Median	87
Standard deviation (SD)	7.76
Usability Categories	Excellent
Interpretation	Highly Worth Using

DISCUSSION

The results of the study show that the development of the AaquaikaBiomek application using the Four-D (4D) model is able to produce learning media that is relevant to the needs of students and lecturers in understanding the biomechanics of water sports. The process of defining needs carried out in the early stages revealed that the main difficulty for students in studying aquatic biomechanics is in the aspect of visualization of movement and the connection between the principles of mechanics and the movement phase of water sports. This is in line with the findings (Puel, 2020) and (Kretschmann, 2015) which states that biomechanics learning will be more effective if it is complemented by visual illustrations, motion schemes, and systematic simulations. Obstacles in understanding thrust, water resistance, body position, and movement efficiency prove that students need additional learning media that is able to simplify these concepts. The high needs

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analysis shows that biomechanics learning urgently needs companion digital media, in line with the findings (Yuniarti et al., 2022) that Android-based learning applications can increase motivation and understanding of concepts in sports students.

Application development at the design stage is based on these needs, so application design emphasizes visualization, simplicity, and ease of access. The app's design that combines text, images, swimming phase illustrations, and biomechanics theory summaries provides a more meaningful learning experience. This design supports multimedia theory (Mayer, 2009) which emphasizes the importance of integrating text and visuals in the learning of complex concepts. The simple menu structure also helps students to navigate the application easily, according to the recommendations (Ningrum & Cahyono, 2021) which confirms that the design of the user interface greatly influences the level of use of digital media in learning.

At the Develop stage, expert validation provides an idea that the application of AaquaikaBiomek has met the feasibility standards in terms of material, media, and technical aspects. The feasibility value of 95.83% shows that the biomechanics material has been poured accurately and in accordance with the characteristics of aquatic learning. Expert input on the app's ease of navigation and visual customization shows the importance of adapting content to suit students' level of understanding. The revision process improves navigation, readability, and visual comfort so that the app becomes more user-friendly. These findings are consistent with the theory of media development according to (Prastowo, 2020) which emphasizes that validation and revision are an important part of producing quality products.

The Disseminate stage shows that the AaquaikaBiomek application is feasible to be implemented in aquatic lectures with a Usability score of 87.01. According to (Sauro, 2018) An application or web page is categorized into several levels of

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usability based on the usability value measured using SUS, a value of 50 and below is considered a failed product, while a value of >80 is good.

The results of the study show that the application of AaquaikaBiomek is effective as a supporting medium for learning biomechanics of aquatic sports. The success of this application is mainly influenced by the clear visualization of concepts, the presentation of structured materials, and the design of applications that are easy for students to operate. This application has the potential to be a supporting learning medium in water sports and biomechanics courses, while contributing to improving the quality of digital-based learning in a physical education environment.

CONCLUSION

This research succeeded in developing the Android application AaquaikaBiomek as a digital learning medium to support the understanding of aquatic sports biomechanics. The development process is carried out through the Four-D model (define, design, develop, and disseminate) systematically and oriented to user needs. The results of the needs analysis show that students need visual learning media that can help them understand abstract concepts of water biomechanics.

The application developed contains video-based motion analysis features, swimming motion phase simulation, and interactive learning modules relevant to biomechanics materials. Validation by experts shows that the app has a content validity of 95.83% and a media validity of 93.75%, both of which are in the very viable category. The user feasibility test gives a usability score of 87.01, which indicates the app is easy to use, engaging, and supports the learning process. This application can be applied to face-to-face, hybrid, or independent learning to improve the understanding and ability to analyze the movement of Physical Education students.

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