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Development of interactive media digital applications through a deep learning approach in the automotive concentration

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Abstract

This research aims to develop interactive learning media based on digital applications that can improve students' conceptual understanding and skills in the automotive concentration through the application of a deep learning approach. The development of this media is motivated by the need for learning innovations that integrate digital technology with deep learning strategies so that students not only memorize procedures but also comprehensively understand the working principles of automotive systems. The research method used is Research and Development (R&D) with the Borg & Gall model which includes the following stages: (1) needs analysis, (2) product design, (3) interactive media development, (4) validation by media experts and material experts, (5) limited trials, and (6) revisions and field trials. The research subjects came from students of the Automotive Engineering Education study program at Muhammadiyah University of Purworejo. Data collection used surveys, in-depth interviews, and Focus Group Discussions (FGD) in designing learning media. The results of the study indicate that the interactive media developed using the deep learning platform showed that the indicator with the highest score was ease of access (4.50), followed by industry relevance (4.40) and feedback (4.40), which both ranked second. Next, material completeness (4.30) and technological innovation (4.30) ranked next, followed by interactive displays (4.20). Automatic evaluation indicators (4.10) and simulation quality (4.10) ranked next with the same score. The lowest scores were for learning flexibility (4.00) and online collaboration (4.00), indicating a need for further development in both aspects. Overall, this ranking demonstrates the platform's superior accessibility and industry relevance, although improvements in flexibility and online collaboration are still needed. Therefore, this interactive media, based on digital applications using the Deep Learning approach, is effective as an innovative learning tool in the automotive sector.

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Keywords

Interactive media, Digital applications, Deep learning, Automotive, Innovative learning

Introduction

The development of digital technology and changing demands of the vocational industry, including the automotive sector, have opened up both opportunities and challenges for vocational education. The era of the Fourth Industrial Revolution (Industry 4.0) demands that students not only memorize procedures but also understand concepts, master skills, and be able to think critically and solve real-world problems in automotive systems. Therefore, learning in the automotive concentration field needs to be supported by innovative media and strategies.

Several studies have shown that the use of interactive digital media can increase student motivation and participation. For example, in secondary schools the use of interactive digital media has been shown to have an impact on student learning motivation [1]. In the automotive sector in particular, [2]. Furthermore, in the context of learning approaches, the concept of the Deep Learning Approach (which in education is often interpreted as in-depth learning: meaningful, mindful, joyful) is important to encourage students towards a deeper understanding of concepts, not just memorization. For example, conceptual research suggests that deep learning in education can increase student engagement, strengthen conceptual understanding, and support cognitive and affective development. In secondary schools it was also found that efforts to integrate the four elements of deep learning (real-world connections, personalization, student collaboration, use of technology) made a positive contribution to learning transformation [3], [4].

Problems related to learning using a deep learning approach need to be solved because the deep learning approach actually encourages deep understanding for students, integration of knowledge, and application in real situations, instilling a lifelong learning mindset [3]. Significant impacts are seen in increased participation, learning outcomes, and students' ability to apply knowledge in new contexts. The need to prepare students to face global challenges is the basis for the implementation of deep learning [5]. Dynamic educational trends are making deep learning increasingly relevant, focusing on in-depth understanding and application of knowledge in various contexts, not just information acquisition. Its integration into the curriculum aims to develop students' adaptive skills to rapidly changing society and the world of work. Beyond deep learning, meaningful learning plays a crucial role, occurring when students connect new information with existing knowledge, resulting in deeper understanding, increased motivation, and facilitating comprehension of the material. A curriculum that supports meaningful learning creates more relevant and engaging learning experiences, ultimately improving student learning outcomes and engagement [6].

The support of interactive digital application media is very necessary for the learning process through a deep learning approach. This will help students in learning each material. The use of media as a learning tool will have a positive impact on the process and results of student learning [4]. The use of interactive media can increase student interest and provide good learning outcomes so that it can help meet 21st century

competencies so that they can compete globally [10]. Learning media is the main key in the renewal and development of the learning process [11], [12]. According to the Association for Education and Communication Technology (AECT), media is any form used to distribute information that can stimulate thoughts, feelings, attention and the ability to learn [10].

The theme of this research is related to the development of interactive digital application media to support learning through a deep learning approach. The use of media is very necessary because with the existence of appropriate media, students' literacy skills will be better [3], [13]. The formulation of the problem in this research is How to develop interactive learning media based on digital applications that can improve students' understanding of concepts and skills in the automotive concentration.

Method

This research is a type of research and development (R&D). [14] states that development research is a systematic process that includes designing, developing and evaluating learning products in the school environment, by ensuring that the product is valid and effective for use. Development research is used to create products according to certain criteria, while also evaluating the level of effectiveness and feasibility, both for new products and modified products to ensure their functionality when implemented [15].

The research method used is Research and Development (R&D) with the Borg & Gall model which includes the following stages: (1) needs analysis, (2) product design, (3) interactive media development, (4) validation by media experts and material experts, (5) limited trials, and (6) revisions and field trials. The research subjects came from students of the Automotive Engineering Education study program at Muhammadiyah University of Purworejo. Data collection used surveys, in-depth interviews, and Focus Group Discussions (FGD) in designing learning media. Research instruments included validation questionnaires, observation sheets, and learning outcome tests. This research was limited to the development stage because the researcher focused on the product being developed, while the implementation stage was expected to be continued by subsequent researchers. The research design scheme can be seen in Table 1.

Table 1. Research Design Scheme

No	Main Activity Stage	Expected Results
1	Needs analysis	Data on automotive learning issues
2	Planning	Media design and deep learning plan
3	Initial product development	Digital application prototype
4	Limited trial	Initial user feedback
5	Product revision	Improved revised version
6	Field trial	Media effectiveness data
7	Operational revision	Final product ready for use

The initial stage of this research is a needs analysis focused on analyzing problems that occur in the school environment related to the use of learning media, whether it is relevant to the needs of students, and if it is not relevant, an analysis is conducted as a solution to determine which products will be developed to support the learning process. This aims to identify problems and needs in the field.

The steps taken are: (1) Conducting observations in class to determine how the learning process is taking place. (2) Interviews with students to directly identify problems. (3) Collecting literature on Deep Learning-based learning and the development of interactive digital media. The results of this stage are expected to obtain data on student needs as a basis for developing interactive media that can display automotive system simulations and encourage in-depth understanding (deep learning).

The next stage is planning, which includes planning media development and the learning approach to be used. The steps taken are: (1) Determining the development objective, namely producing digital interactive media for automotive learning using a deep learning approach. (2) Compiling product specifications, such as interactive features (engine system animations, quizzes, troubleshooting simulations). (3) Determining the automotive teaching materials that will be used as content.

The development stage begins with the realization of the product design that has been prepared. Next, a review and validation process is carried out by material, language, and media experts. After obtaining input from experts, analysis and revisions are carried out on the product created. Finally, a limited trial is conducted. The review, validation, and revision stages can be carried out more than once to obtain a good final product. Next, the implementation stage, the media is used directly in learning to test the effectiveness of the product in a real context. This process is accompanied by an initial evaluation to obtain direct feedback that will become a guideline for further improvement or development [16]. The results of the field trial will obtain data on the effectiveness of media use, from this data then used as a reference in revising the product until a final product is ready for use.

The subjects in this study included material experts from lecturers and teachers, expert lecturers, media experts, and 5th semester students of the Automotive Engineering Education Study Program at Muhammadiyah University of Purworejo. The data used consisted of primary and secondary data. Primary data included the results of expert reviews and validations as well as student response questionnaires. Meanwhile, secondary data were sourced from supporting literature on the media development process, such as scientific journals, reference books, and relevant previous research results [14]. Data collection techniques included observation, interviews, and questionnaires. Open questionnaires were used to collect input from experts, while closed questionnaires were used to measure the feasibility of the media and student responses. All data were analyzed using qualitative and quantitative descriptive approaches. Input from experts was analyzed qualitatively to be used as a basis for

media improvement. Quantitative data was analyzed using a Likert scale for media validation and student responses. All data was converted into an assessment score.

Results

The problem-solving approach involves analyzing the problem and then developing an initial conceptual model. This conceptual model is then examined through design trials and research and development. The following is the conceptual model developed in this study (Figure 1).

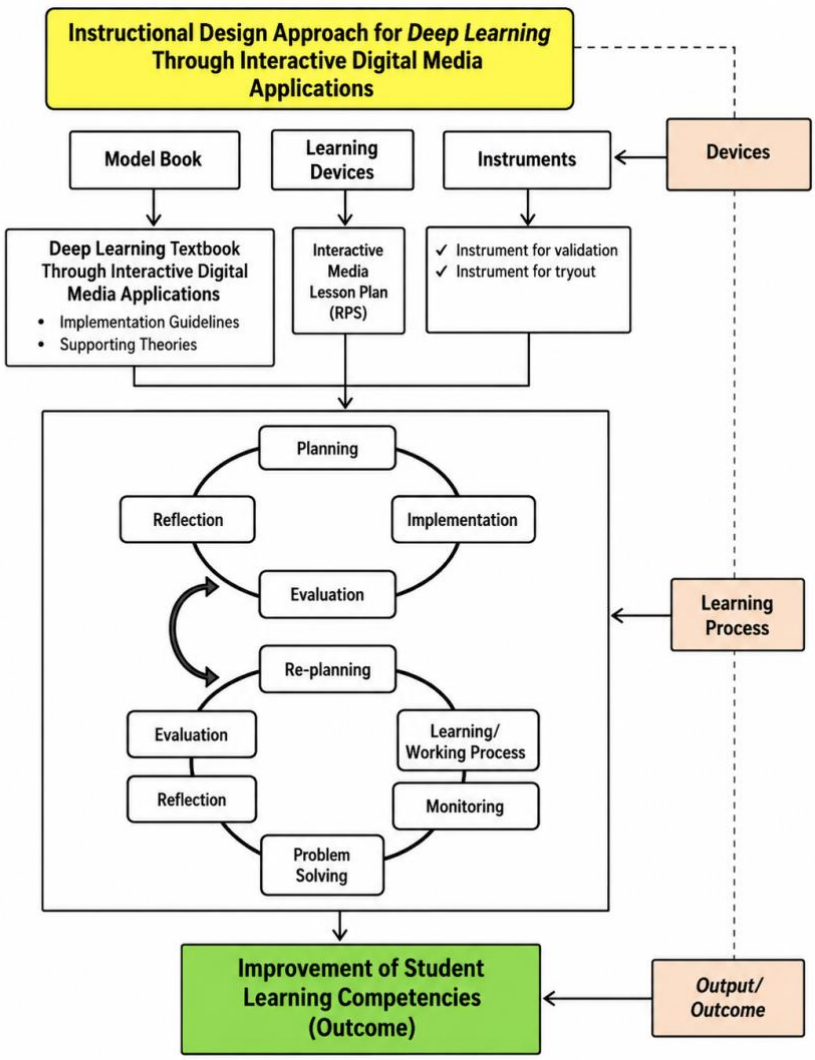

Figure 1. Conceptual design

The concept of this model starts from compiling devices, learning processes and outputs/outcomes [17], [18], [19]. The devices start from model books, learning devices/media and instruments [20], [21], [22]. In the learning process by integrating interactive digital application media and learning through a Deep Learning approach.

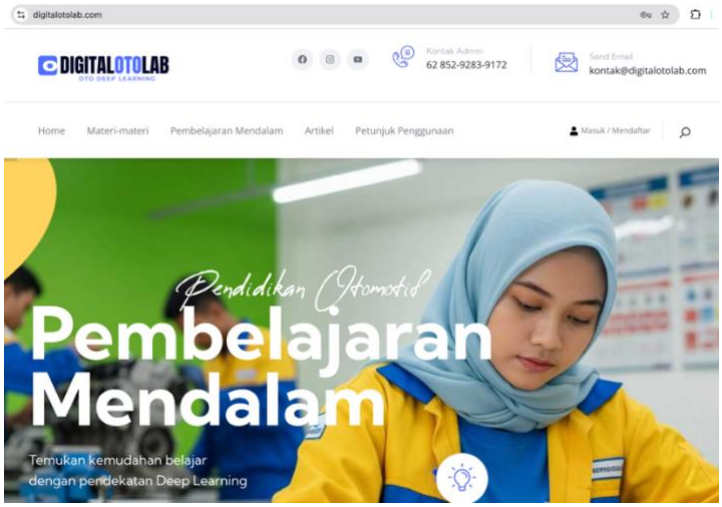

Figure 2. Deep learning platform

The DigitalOtolab.com platform was developed as an automotive learning solution integrated with deep learning, aiming to provide an adaptive learning experience that focuses on both practical and theoretical skills (Figure 2). Through the integration of artificial intelligence technology, the platform is able to present visual materials and interactive simulations, diagnose each learner's abilities, and tailor learning content to their specific needs.

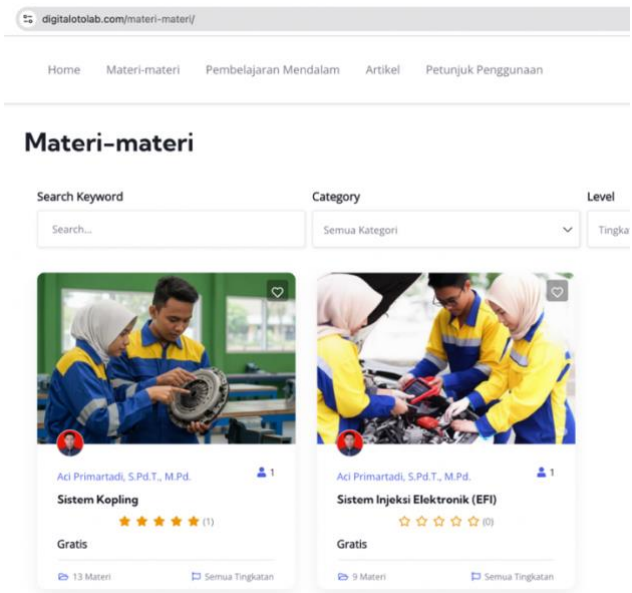

Figure 3. Deep learning platform material

The DigitalOtolab.com platform contains a variety of automotive learning materials packaged in an integrated manner using a deep learning approach, making it easier for students to understand concepts both theoretically and practically (Figure 3). Available materials include fuel injection systems, which discuss their working principles, main components, and damage analysis; clutch systems, which cover their functions, types, working mechanisms, and maintenance methods; and a number of other automotive materials such as transmission systems, braking systems, electrical systems, and modern sensor-based vehicle technology.

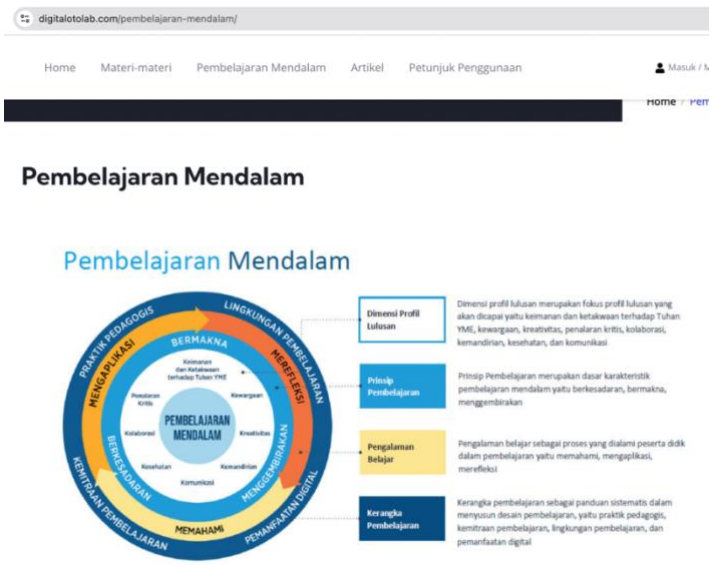

Figure 4. Integration of automotive material with a deep learning approach

The integration of automotive materials with a deep learning approach enables the learning process to be more adaptive, interactive, and tailored to the needs of both students and industry. Through this technology, materials such as injection systems, clutch systems, transmissions, brakes, and vehicle electrical systems are not only studied theoretically but also visualized through digital simulations, data analysis, and real-life case studies. The deep learning approach helps students develop conceptual understanding and practical skills gradually, with automated feedback and personalized materials tailored to their competency level (Figure 4).

From the results of this study, data was obtained in the form of validation results of deep learning models with digital applications (Figure 5).

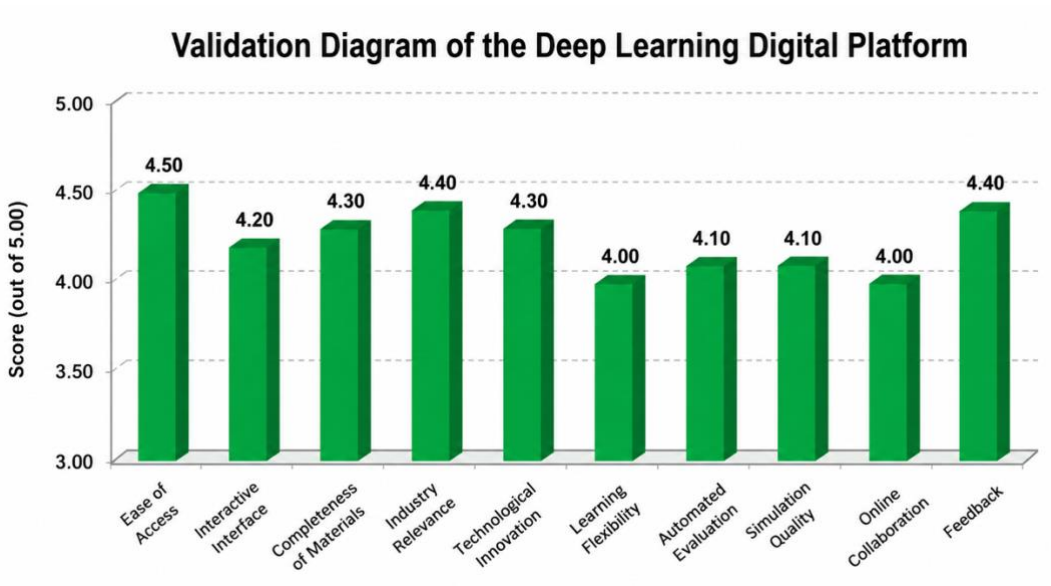

Figure 5. Validation diagram of the deep learning digital platform

Validation results show that the DigitalOtolab.com immersive learning platform achieved high average scores across almost all indicators. The highest score was for ease of access (4.50), followed by industry relevance (4.40), and feedback (4.40). This indicates that the platform is easy to use, practical to access, and user-friendly. The aspects of material completeness (4.30), interactive displays (4.20), and technological innovation (4.30) also received good ratings, indicating that the learning content is aligned with the needs of the automotive industry and supports the digital transformation process of vocational education. These findings align with research [6] which states that the use of digital multimedia in automotive engineering learning can increase student engagement, facilitate access to information, and significantly improve learning outcomes. Thus, ease of access and interactive design are key factors in the effectiveness of technology-based learning media [6]. Furthermore, high industry relevance (4.40) indicates that the platform development has been tailored to the competency needs of the workforce. This supports research findings that emphasize the importance of implementing work-based learning to bridge the gap between graduates' abilities and industry needs [16].

Discussion

The application of the deep learning approach in the development of the DigitalOtolab.com platform shows a learning direction that emphasizes conceptual understanding and reflection. This approach differs from surface learning which only focuses on memorization, because deep learning encourages learners to connect new ideas with previous experiences and knowledge [23]. The results of the automatic feedback that obtained a high score (4.40) indicate that the system has been able to provide a fast and relevant response to user learning activities. This supports the constructivist theory that emphasizes the importance of direct feedback to build meaningful knowledge [20]. These results are also in line with research [16], which found that the application of the deep learning approach in vocational education significantly increases student motivation, critical thinking skills, and learning outcomes.

Although the overall results show a “very good” category, there are several aspects with lower scores, namely Learning flexibility (4.00), This score indicates the need to improve the system's ability to adapt to the user's learning style and time. In the context of e-learning, flexibility is one of the main indicators of successful implementation [18]. Learners in vocational education often require varying learning times, especially when practice is carried out outside of face-to-face hours. Therefore, providing offline modes, mobile learning, or adaptive scheduling is very important to increase platform flexibility. Automatic evaluation (4.10), Automatic evaluation systems still need to be developed to accurately assess cognitive and psychomotor aspects. [9] emphasized that the integration of learning analytics can improve assessment accuracy and provide adaptive feedback according to user performance. In the context of automotive learning, evaluation includes not only the results of the answers, but also the diagnostic and

procedural processes carried out by students. Simulation quality (4.10), Simulation is a key component in digital-based automotive learning. However, this score indicates that the realism of the simulation and the responsiveness of the system still need to be improved. High-realism simulations directly impact the transfer of practical skills from virtual environments to the real world. Therefore, improvements to 3D animation, sound effects, and mechanical component interactions are key recommendations. and Online collaboration (4.00). This score indicates that collaborative features are still suboptimal. However, in immersive learning, collaboration plays a crucial role in enhancing conceptual understanding through discussion and collaborative problem-solving. The addition of discussion forums, project workspaces, and peer evaluation systems can enhance collaborative aspects while supporting students' social skills.

The validation results show that the DigitalOtolab.com platform has fulfilled the characteristics of effective learning media in the context of vocational education, namely Interactive and easy to use, according to multimedia theory which states that effective learning occurs when media is able to integrate visuals, text, and interactions in a balanced manner. Contextual to the world of work, as suggested by the work-based learning model [17] which emphasizes learning based on real work experience. And encourages deep learning, in line with the view [24] that learning designs that emphasize understanding, reflection, and integration of concepts will produce deep learning outcomes. Thus, these results strengthen the theory that the integration of digital media and deep learning approaches can increase engagement and learning outcomes in the field of automotive engineering.

Overall, the validation results indicate that DigitalOtolab.com falls into the "feasible and effective" category as a digital-based automotive learning medium. This product successfully combines pedagogical elements, technology, and industry needs in a balanced manner (Figure 6). However, further improvements need to focus on dynamic features that support flexibility, adaptive evaluation, and ongoing online collaboration to make learning more meaningful and contextual.

The assessment of the immersive learning platform showed that the highest-scoring indicator was ease of access (4.50), followed by industry relevance (4.40) and feedback (4.40), which both ranked second. Next, comprehensiveness of materials (4.30) and technological innovation (4.30) ranked next, followed by interactive displays (4.20). Automatic evaluation indicators (4.10) and simulation quality (4.10) ranked next with the same scores. The lowest scores were for learning flexibility (4.00) and online collaboration (4.00), indicating a need for further development in both aspects. Overall, this ranking illustrates the platform's strengths in accessibility and industry relevance, although improvements in flexibility and online collaboration are still needed.

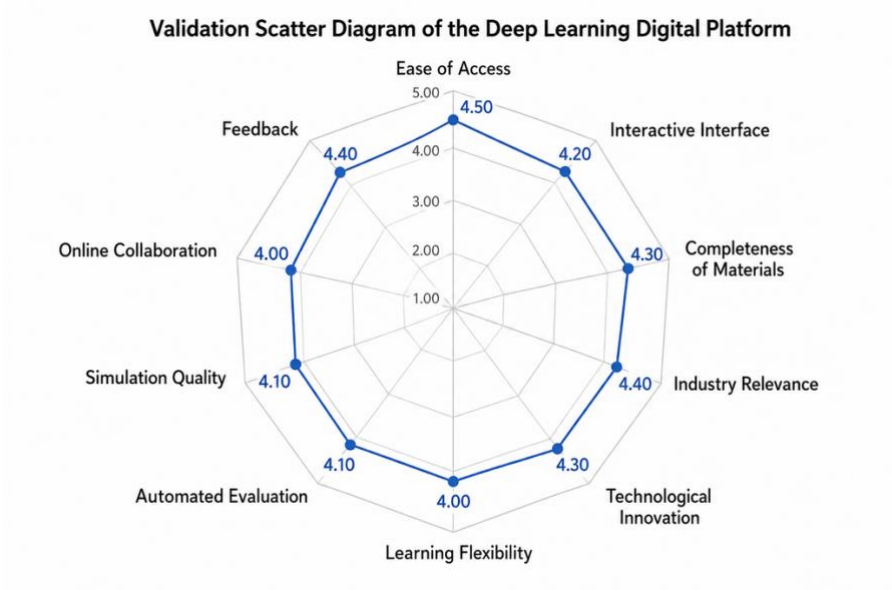

Figure 6. Validation scatter diagram of the deep learning digital platform

Conclusion

This study concludes that interactive digital application-based media has been systematically developed using the Research and Development (R&D) method with the Borg & Gall model. This media is deemed suitable for use in automotive learning because it presents material visually, interactively, and contextually according to students' needs. This finding provides a solution to the lack of engaging media that meets the demands of 21st-century learning.

The DigitalOtolab.com platform, as an automotive learning medium, obtained data showing that most indicators received high scores, including ease of access (4.50); industry relevance (4.40); and feedback (4.40), indicating good user acceptance and content suitability to the needs of the workplace. The integration of a deep learning approach into the platform design successfully encouraged cognitive engagement and student reflection, as evidenced by high scores in the feedback and material comprehensiveness aspects, thus supporting conceptual and applicative understanding. Technological innovation, interactive displays, and material comprehensiveness received positive assessments, indicating that the platform has incorporated multimedia elements and digital features relevant to automotive vocational learning. The platform has the potential to enrich the vocational learning model by combining industry-based theory, simulation, and reflection; however, optimal effectiveness is achieved when combined with field practice (work-based learning) and enhanced simulation features and adaptive evaluation.

This study has limitations in its implementation scope, as it was only conducted on a small-scale trial and did not quantitatively measure the direct impact on learning outcomes. Furthermore, the trial was limited and did not cover a variety of student characteristics. Future research is expected to evaluate the effectiveness of the media more broadly through relevant research approaches, involving more students from

various educational institutions, and developing similar media for other learning topics. It is also necessary to develop media that can be accessed offline as an alternative when internet connections are unstable, to make the media more inclusive and applicable in various learning conditions.

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