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ACCELERATING STUDENT UNDERSTANDING THROUGH THE DEVELOPMENT OF HOLOGRAPHIC LEARNING MEDIA FOR THE INNOVATION MANAGEMENT COURSE

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Abstract
The transformation of education in the digital era demands innovative learning media that can strengthen students' understanding and retention. This study developed holography-based learning media in the Innovation Management course with the aim of accelerating the comprehension of abstract concepts and enhancing students' ability to apply theory in practice. The method used was Design-Based Research (DBR), which includes problem identification, design, implementation, testing, and refinement of the media. Data were collected through pretests, posttests, and questionnaires to assess media effectiveness. The results showed that holography-based media improved students' understanding of fundamental innovation management concepts such as design thinking, idea generation, and innovation diffusion in a more concrete way, strengthened long-term retention through multisensory experiences, and increased students' confidence in analyzing case studies and developing Business Model Canvas (BMC). In addition, the sharp visual quality, ease of access, and technical stability of the media supported a smooth learning process without disruption. Holography has proven to be an innovative, effective, inclusive, and relevant learning medium to prepare students for the challenges of an innovation-driven world.
Keywords: holography, innovation management, interactive learning

Abstrak
Transformasi pendidikan di era digital menuntut adanya inovasi media pembelajaran yang mampu memperkuat pemahaman dan retensi mahasiswa. Penelitian ini mengembangkan media pembelajaran berbasis holografi pada mata kuliah manajemen inovasi dengan tujuan mempercepat pemahaman konsep abstrak dan meningkatkan kemampuan mahasiswa dalam mengaplikasikan teori ke dalam praktik. Metode yang digunakan adalah Design Based Research (DBR) yang meliputi identifikasi masalah, perancangan, implementasi, uji coba, dan penyempurnaan media. Data diperoleh melalui pretest, posttest, dan angket untuk menilai efektivitas media. Hasil penelitian menunjukkan bahwa media holografi mampu meningkatkan pemahaman mahasiswa terhadap konsep dasar manajemen inovasi seperti design thinking, idea generation, dan innovation diffusion secara lebih konkret, memperkuat retensi jangka panjang melalui pengalaman multisensori, serta meningkatkan kepercayaan diri mahasiswa dalam menganalisis studi kasus dan menyusun Business Model Canvas (BMC). Selain itu, aspek visual yang tajam, kemudahan akses, dan stabilitas teknis media mendukung kelancaran proses belajar tanpa gangguan. Holografi menjadi media pembelajaran inovatif yang

efektif, inklusif, dan relevan untuk menyiapkan mahasiswa menghadapi tantangan dunia kerja berbasis inovasi.
***Kata kunci**: holografi, manajemen inovasi, pembelajaran interaktif*

INTRODUCTION

The world of education is facing significant transformations that require adjustments to education with a more inclusive and adaptive approach to student diversity. These changes are not only redefining the traditional classroom structure, but also the way material is taught and learned by students. Innovative digital technologies, such as holography, have emerged as important tools in the evolution of teaching methods, offering new, more interactive and in-depth ways of presenting educational material (Goncharov, 2020). In this context, the use of holography-based learning media supports students' flexibility in understanding material related to design thinking in innovation management courses. Holographic technology, known for its ability to create realistic three-dimensional images without the need for special devices such as 3D glasses, offers unique opportunities in education. Holograms can bring theoretical and abstract concepts in innovation management to life, allowing students to see and interact with visual representations of the material being studied. This is a significant step forward from two-dimensional materials, making the context richer and the experience more intuitive and engaging (Putra et al., 2023).

In innovation management courses, where students are faced with complex theories and practices, methods that can be tailored to student needs, especially in terms of flexibility, are required. Students are expected to absorb all the theory and implement it in innovative ideas with learning media that can be accessed anywhere and anytime. Therefore, the development of learning media must consider effectiveness in delivering content and flexibility in order to realize fair and inclusive education. Holography in education also encourages more collaborative and exploratory teaching and learning (Isa et al., 2023).

Holography, as a technology that enables three-dimensional visualization of abstract concepts, offers great potential in the world of education. Holography-based learning media can change the way students understand material by providing visual representations that can improve information retention and facilitate deeper understanding. Students can work together in the same space to explore complex design thinking material from various perspectives. This approach not only increases student engagement but also facilitates active learning in which students are involved in the learning process and acquire knowledge organically through exploration and direct experimentation with teaching materials.

The implications of using holographic technology in innovation management learning are vast. This technology opens new avenues for educators and learners to create and implement learning media that are not only effective but also innovative (Saputra et al., 2021). By utilizing technological advances, educators can create a more dynamic and engaging learning environment that will ultimately improve the quality of education and expand its accessibility. The methodology used in this study includes a development

design that begins with an in-depth analysis of the needs of students and teachers. The next stage is the design and implementation of holographic media tailored to those needs (Torkan et al., 2023).

Next is the evaluation stage of the holographic learning media implementation, which is carried out through a series of tests, including pre-tests and post-tests to measure the impact of technology on student understanding (Narkglom, 2019). The results of this evaluation allowed researchers to quantitatively assess improvements in understanding and retention of material, as well as qualitatively assess students' impressions and learning experiences. Significant improvements in students' understanding and practical application skills indicate that holography has the potential to revolutionize how material is taught in innovation management courses more comprehensively.

This research not only enriches the academic literature by exploring the practical applications of advanced technology in education, but also makes a significant contribution by offering concrete recommendations for educational institutions intending to integrate innovation into their curricula. Through this article, we wish to emphasize the importance of inclusivity in education, ensuring that learning materials are easily accessible and adaptable for all students. Thus, holographic technology not only facilitates more efficient learning but also supports diversity and inclusion in the educational environment, making it a tool that contributes greatly to efforts to improve the overall quality of education. The world of education is facing a significant transformation that requires education to adapt with a more inclusive and adaptive approach to student diversity. These changes not only redefine the traditional classroom structure, but also the way material is taught and learned by students. Innovative digital technologies, such as holography, are emerging as important tools in the evolution of teaching methods, offering new, more interactive and in-depth ways of presenting educational material (Goncharov, 2020). In this context, the use of holographic-based learning media supports students' flexibility in understanding material related to design thinking in innovation management courses. Holographic technology, known for its ability to create realistic three-dimensional images without the need for additional special devices, such as 3D glasses, offers unique opportunities in education. Holograms can bring theoretical and abstract concepts in innovation management to life, allowing students to see and interact with visual representations of the material being studied. This is a significant step forward from two-dimensional material, making it a richer context and a more intuitive and engaging experience (Putra et al., 2023).

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METHOD

The method used in this study was Design Based Research (DBR), which is a systematic approach to designing and testing innovative solutions in the context of education. DBR involves several main stages, namely: problem identification, solution development, solution testing and refinement, and reflection and implementation (Johnson et al., 2019). The pre-research stage began with the identification of problems in the learning process. Data was collected through interviews with lecturers and students, as well as classroom observations to identify the gap between current teaching methods and student learning needs. The main problem identified was the lack of student engagement and in-depth understanding of Innovation Management materials due to conventional teaching methods that were not interactive and dynamic enough.

The pre-research stage began with the identification of problems in the learning process. Data collection was carried out through interviews with lecturers and students as well as classroom observations to identify the gap between current teaching methods and student learning needs. Next, an in-depth analysis of the collected data was conducted to understand in detail the learning needs and existing gaps. The results of this analysis were used as a basis for developing solutions. The next stage was the development of solutions based on the problem analysis, which resulted in the design of media. The media design took into account technical and pedagogical aspects to ensure that the learning media was not only visually appealing but also effective in delivering the material.

This was followed by the testing and refinement of the solution. The developed learning media was tested in a real learning environment. This process involved testing the functionality and effectiveness of the media using the User Experience Questionnaire (UEQ) and System Usability Scale (SUS) (Amaral, 2020). The final stage is reflection on design and implementation. The results of the evaluation and revision are integrated into the final design of the learning media. The refined implementation process is then retested to ensure that all improvements are appropriate and that the learning media can be used effectively in the long term (Johnson, 2020). Test data collection was conducted quantitatively and qualitatively to measure the impact of holographic learning media users on students. Quantitative data was collected through surveys, while qualitative data was obtained through in-depth interviews with lecturers and students. Data analysis was conducted to identify patterns and trends that indicate the effectiveness of learning media in improving understanding of innovation management material.

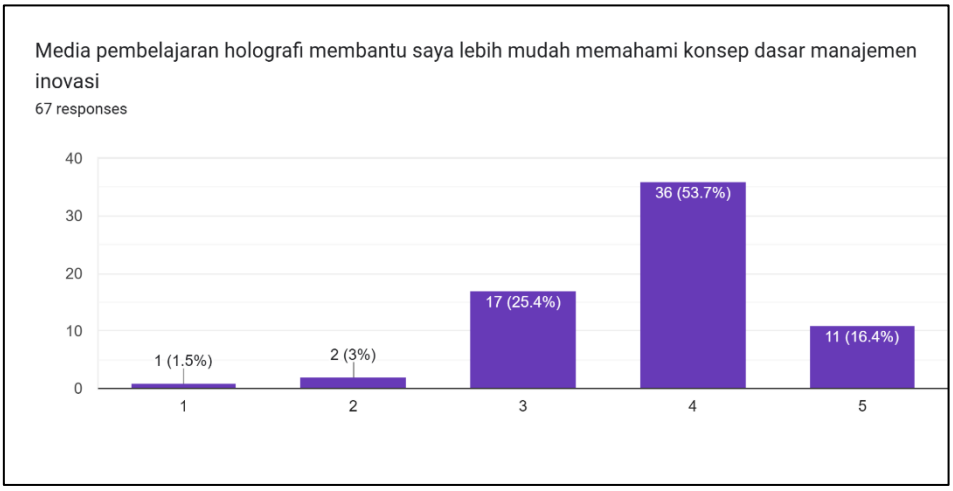
RESULTS AND DISCUSSION

Understanding and retention of material are important indicators of the effectiveness of the learning process, especially in Innovation Management courses that require students to master abstract concepts and apply them in real-world practice. Holographic-based learning media provide opportunities to deliver a more concrete, visual, and interactive learning experience. Three-dimensional visualization of complex concepts helps students

build a more complete mental representation, thereby accelerating the comprehension process (Putra et al., 2023).

The results of the study show that holography helps students understand the basic concepts of innovation management more easily and comprehensively. Abstract concepts such as design thinking, idea generation, and innovation diffusion, which are often difficult to understand through text or two-dimensional images, become more concrete when visualized in three dimensions. Holographic visualization facilitates the formation of clearer mental models, enabling students to internalize core material more quickly (Putra et al., 2023). This is in line with Zhang and Huang (2021), who assert that immersive media can improve students' mental representation, strengthen cognitive pathways, and deepen conceptual understanding.

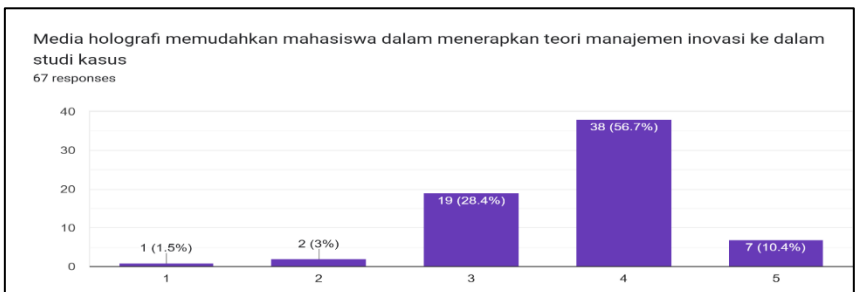
Figure 1. THC survey results make it easier for students to understand the material



In addition, holographic media has been proven to make it easier for students to connect theory with real-world case studies. For example, when students study open innovation theory, holograms can be used to visualize the flow of collaboration between companies or product development simulations. In this way, students not only understand the theoretical framework, but also see firsthand how the concept works in a practical context. Research by Rahman et al. (2022) shows that students who use 3D-based media are better able to map theory to real-world applications than those who only use conventional methods.

In terms of retention, the interactive learning experience provided by holography makes it easier for students to remember the steps in applying theory to specific cases. Isa et al. (2023) found that immersive technology not only increases engagement but also strengthens long-term memory because the material is processed through a multisensory experience. Thus, students are not only able to remember information but also reuse it when faced with real-world problems.

Figure 2. THC survey results make it easier for students to apply the material to case studies.



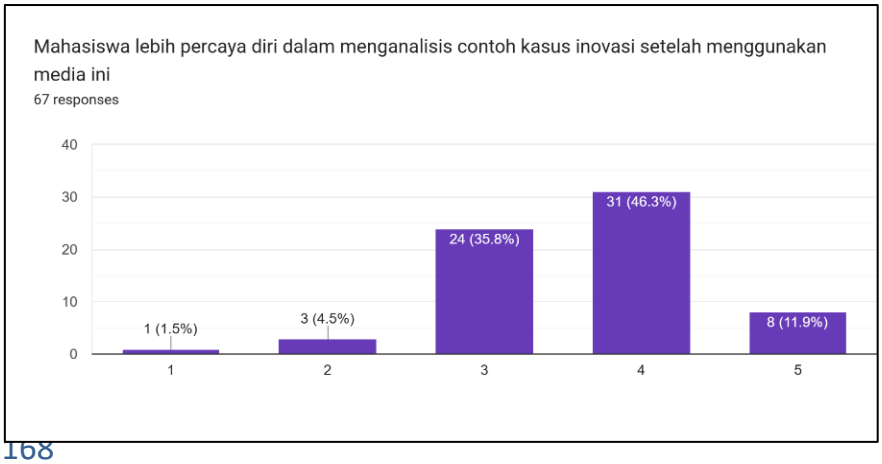
The use of holographic media not only accelerates the understanding of basic innovation management concepts, but also strengthens students' ability to apply theory to various case studies. This implication confirms that holography is not just a visual aid, but also a strategic medium for developing problem-solving skills and preparing students to face the challenges of an innovation-based work environment.

Boosting Student Confidence

Furthermore, holographic media also helps boost students' confidence. Confidence is an important factor that influences the success of the learning process, especially in Innovation Management courses that require students to think critically, creatively, and be able to make theory-based decisions. Observations show that holographic-based visualization provides students with a more concrete learning experience so that they feel more prepared when faced with real-life cases. By seeing a three-dimensional representation of a problem, students find it easier to identify the core of the issue and relate it to the theory they have learned. This fosters confidence that they are capable of constructing logical and argumentative analyses. These findings are in line with the research by Saputra et al. (2021), which states that innovative learning media increases students' self-efficacy in completing analysis-based tasks.

According to Rahman et al. (2022), the use of immersive technology in learning strengthens students' confidence because it provides a deep, interactive learning experience that is relevant to the context they face. In this context, students do not only see theory as something abstract, but as a tool that can be directly applied to solve innovation problems. Holography enables visual-based collaboration, where students jointly explore visualized innovation cases. This process encourages them to be more confident in presenting ideas, arguing, and testing the solutions they offer. Isa et al. (2023) emphasize that immersive media-based collaborative learning not only improves understanding but also fosters confidence in communicating analysis results.

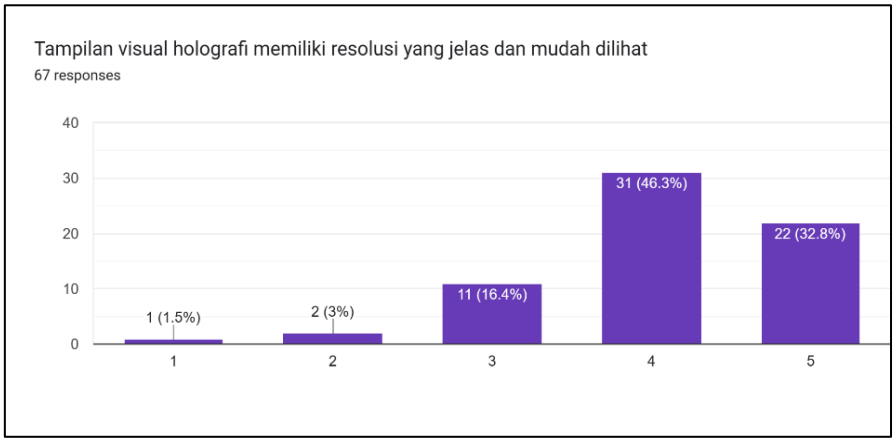
Figure 3.THC survey results increase student confidence



Ease of Access to THC

Improved understanding, retention, and confidence among students in analyzing innovation cases cannot be separated from the visual quality and technical aspects of the holographic media used. The clarity of the visual display is a major factor that makes it easier for students to understand the details of the concept and feel more confident when relating it to real case studies. The holographic media presented in this study has high resolution so that every three-dimensional object is clear, detailed, and easy to observe. This sharp visualization helps students focus on the core material without being distracted by display limitations. This is in line with the findings of Zhang & Huang (2021), which show that good immersive media resolution can reduce cognitive load while strengthening conceptual understanding

Figure 4. THC survey results have good visuals

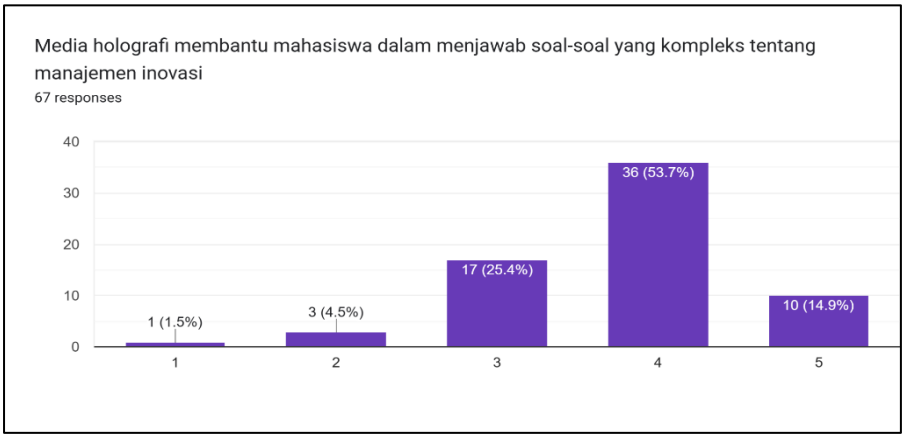


In addition to visual aspects, another advantage of holographic media lies in its technical stability. Test results show that the media can be accessed smoothly without any lag or interference that could disrupt students' concentration. This condition is very important because learning experiences that are hampered by technical interference often reduce motivation and learning effectiveness. Research by Torkan et al. (2023) confirms that technical reliability, including system response speed and minimal interference, is an important requirement for the successful implementation of holographic technology in learning. Ease of access is also an added value of this media. Students do not need complex additional devices, so they can use holography flexibly both in class and independently. Isa et al. (2023) state that ease of access and affordability are important factors in increasing the sustainable adoption of innovative learning technologies in higher education.

Figure 5. THC survey results are easily accessible

Interactive three-dimensional visualizations make it easier for students to understand the interrelationships between concepts, enabling them to systematically analyze complex problems. This is particularly helpful when students are faced with case study analysis questions that require the integration of theory, logic, and creativity. Research by Rahman et al. (2022) shows that the use of immersive media can improve students' problem-solving abilities by providing a rich contextual experience. Often, questions in Innovation Management courses require students to connect abstract theories with practical phenomena, for example, in analyzing product development strategies, innovation diffusion patterns, or market competition dynamics. In this context, holographic media acts as cognitive scaffolding that makes it easier for students to structure their answers in a more coherent and argumentative manner.

Figure 6. THC survey results make it easier for students to answer exam questions.

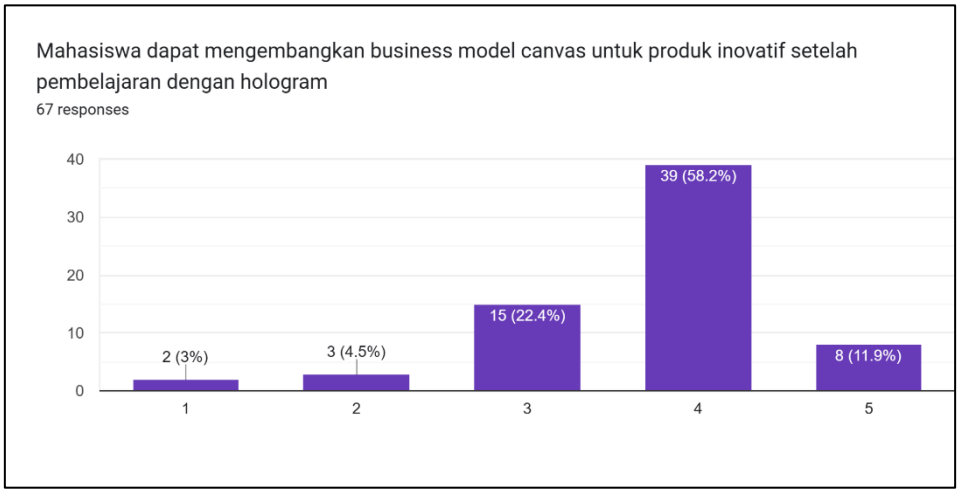


Not only limited to answering questions, holographic media also facilitates students in developing a Business Model Canvas (BMC) framework for innovative products. Through holographic visual displays, students can see simulations of value streams, partner networks, and market segmentation in a three-dimensional format that is easier to understand. This process makes them more confident in designing realistic and applicable business strategies. This finding is in line with Isa et al. (2023), who assert that immersive media improves students' ability to connect theory with practice, especially in designing innovation-oriented business models.

In addition, the ability to develop BMC through holographic support also strengthens the aspect of collaboration. Students can work in groups to discuss components of value propositions, key resources, and revenue streams interactively with the help of visual representations provided by the media. This is in line with Putra et al. (2023), who stated

that hologram-based visualization can enrich group discussions, encourage innovative ideas, and increase accuracy in business model development.

Figure 7. THC survey results facilitate students in developing BMC



CONCLUSION

The use of holographic-based learning media significantly improves learning effectiveness in Innovation Management courses. Holographic technology provides an interactive, concrete, and immersive learning experience that helps students gain a deeper understanding of abstract concepts such as design thinking and innovation diffusion. Three-dimensional visualization not only strengthens understanding and retention of material, but also builds students' confidence in linking theory with real-world practice. Technical aspects such as high visual quality, system stability, and ease of access without additional devices make holography a flexible, inclusive, and adaptive learning medium for students' needs. In addition to improving academic competence, this medium is also relevant to the demands of the modern workplace because it fosters critical, collaborative, and creative thinking skills in developing innovative solutions and Business Model Canvas (BMC). Thus, holography not only functions as a visual aid but also as a strategic innovation that supports meaningful learning, strengthens student self-efficacy, and promotes quality, inclusive, and future-oriented education.

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