The Influence of Learning Styles and Supporting Factors on Academic Performance of High-Achieving Students

ABSTRACT

This study aimed to develop and evaluate AutoCAD digital learning media using the 4D Research and Development (R&D) method. The method consists of four stages: Define, Design, Develop, and Disseminate, with the goal of improving students' architectural engineering drawing skills. The study involved 21 architecture students who participated in the pre-test and post-test to assess the effectiveness of the developed learning media in improving their architectural engineering drawing skills. The media development process involved several stages, including needs analysis and instructional design. The final stage involved creating interactive digital content that is relevant to the needs of modern students. The effectiveness of the learning media was evaluated through an experimental design involving a group class. The evaluation consisted of a pre-test and post-test to assess the improvement in students' architectural drawing skills. The results revealed a significant increase in post-test scores compared to the pre-test, indicating that the digital learning media was effective in enhancing students' architectural drawing skills. Students provided positive feedback on the interactivity and practicality of the learning media, indicating their satisfaction with the learning experience. The study's findings confirm the significant potential of digital learning media in architecture education. Furthermore, the study suggests that there is a need for further integration of digital technologies in the architecture curriculum to enhance learning outcomes. Future research should focus on larger scale testing to validate the effectiveness of the digital learning media. Additionally, content development should cover a wider range of architectural design aspects to ensure the learning media remains relevant and comprehensive. Future research directions could include exploring the long-term retention of skills and investigating the impact of different instructional approaches on learning outcomes.

Keywords: *Digital Learning Media, AutoCAD, 4D R&D, Architectural Drawing Techniques, Educational Evaluation.*

INTRODUCTION

The rapid development of digital technology has significantly impacted various aspects of life, including the education sector, which has seen significant transformations in recent years. AutoCAD is a computer-aided design (CAD) software developed by Autodesk. Its flexibility and functionality make it a widely used tool in architectural drawings. Architects and engineers rely heavily on AutoCAD to create 2D and 3D drawings, which are crucial components of the architectural design process (Pal, 2023). AutoCAD offers a range of features that simplify the drawing process and enhance precision. These features also enable effective design visualization, which is critical in architectural design.

The integration of digital learning media, such as AutoCAD, has significantly impacted architectural education, transforming the way students learn architectural drawing techniques.AutoCAD serves as a platform for students to improve their design skills. Additionally, it enables students to understand spatial relationships and produce detailed architectural drawings accurately and efficiently.By incorporating AutoCAD into the curriculum, students can gain hands-on experience in digital drafting, 2D and 3D modeling, and visualization, which prepares them for real-world architectural practice and enhances their skills in these areas (Gül, 2015).

In conclusion, AutoCAD plays a pivotal role in architectural drawing by providing architects with the necessary tools and capabilities to create, visualize, and communicate architectural designs effectively, thereby enhancing the overall design process.The integration of AutoCAD into architectural education significantly enhances students' learning experience. This is because it provides them with essential skills that are crucial for excelling in the dynamic field of architecture.

The computer-aided design (CAD) software developed by Autodesk, has played a pivotal role in the practice of architectural drawing since its launch in 1982, transforming the way architects approach design and visualization.AutoCAD was originally released as a desktop application for creating 2D drawings. This marked a significant shift in the architectural design process, as it provided a digital

platform for architects to create precise and detailed drawings.As technology advanced, AutoCAD evolved to include 3D modeling capabilities, enabling architects to visualize designs in three dimensions and enhance the presentation of architectural projects, thereby expanding the scope of architectural design Shams (2018).

The evolution of AutoCAD is marked by continuous updates and improvements to its features and functions, which have significantly enhanced its capabilities and usability.AutoCAD has adapted to technological advancements, including enhanced rendering capabilities and an improved user interface. This has made it a versatile tool for architectural design and documentation, particularly in the context of Building Information Modeling (BIM) workflows (Hendraningrat & Fauziah, 2021). In addition to its core features, the evolution of AutoCAD has seen the integration of cloud-based collaboration tools, mobile apps, and automation features, which have further enhanced its usability and efficiency in architectural practice (Riami et al., 2021).

In architectural education, the shift from traditional teaching methods to digital learning media, such as AutoCAD, has significantly impacted the way students learn and acquire architectural drawing techniques.Traditional methods typically involve manual drawing and sketching. In contrast, digital learning media such as AutoCAD provide students with hands-on experience in digital drawing, 2D and 3D modeling, and visualization (Marlissa et al., 2021). By incorporating AutoCAD into the architecture curriculum, students can develop essential skills in digital design, spatial planning, and engineering drawings, which prepares them for careers in architecture and related fields and enhances their employability (Sabran et al., 2021).

The integration of digital learning media, such as AutoCAD, in architectural education provides students with the opportunity to explore complex design concepts, experiment with different architectural styles, and collaborate on design projects in a digital environment, thereby enhancing their learning experience.By utilizing AutoCAD capabilities, students can enhance their creativity, problem-solving skills, and technical abilities. This enables them to gain a competitive advantage in the architecture industry (Galih, 2023). Furthermore, digital learning media offers flexibility, accessibility, and interactivity, which enables students to engage with architectural concepts in a dynamic and immersive learning environment, thereby enhancing their overall learning experience. (Amran et al., 2022).

In conclusion, the evolution of AutoCAD has significantly impacted the practice of architectural drawing, providing architects with a powerful tool for design, visualization, and documentation, thereby enhancing the overall design process. The integration of digital learning media such as AutoCAD in architectural education enhances students' learning experience. This enables them to acquire the necessary skills and knowledge to succeed in the dynamic field of architecture.

Based on the background of the problems described above, the following problems can be formulated:

How is the effectiveness of digital learning media design for architectural drawing techniques using AutoCAD?

The integration of digital learning media, such as AutoCAD, in architectural education has revolutionized the way students learn architectural drawing techniques. However, the effectiveness of these digital tools in enhancing students' learning experience and skills remains a crucial concern. This problem aims to investigate the impact of digital learning media on students' cognitive gains and problem-solving skills in architectural drawing techniques using AutoCAD. Specifically, it seeks to compare the effectiveness of direct instruction and discovery methods in computer-assisted instruction (CAI) format for learning architectural concepts through the study of precedents in design studio

The objectives of this research are to test the effectiveness of digital learning media design for architectural drawing techniques using AutoCAD. Specifically, the study aims to evaluate the effectiveness of the developed learning media in improving architectural drawing skills using AutoCAD among architecture students. This evaluation will involve measuring the improvement of students' skills, conceptual understanding, and applicative ability.

The research benefits of this study can be categorized into two main areas: theoretical benefits and benefits for higher education. Theoretical benefits include the development of a theoretical framework for effective learning media design. This framework can serve as a reference for future research, providing a foundation for understanding the principles and best practices of learning media design. Additionally, the study's findings can contribute to the existing body of knowledge in the field, enhancing our understanding of the role of digital learning media in enhancing student learning outcomes. In terms of benefits for higher education, the development of more effective and engaging learning materials can lead to increased student satisfaction and potential for success. This, in turn, can raise the academic profile of the institution, as students are more likely to achieve their academic

goals and graduate with a higher level of proficiency. Furthermore, the study's findings can inform the development of more effective learning strategies and materials, ultimately enhancing the overall quality of education provided by the institution.

Challenges in Architectural Education

Architectural education faces several challenges that can hinder students' learning outcomes. These challenges include:

1. Limited Interactive Learning Resources: Traditional teaching methods often rely on manual drawing and sketching, which can be less engaging and practical for modern students.
2. Steep Learning Curve: The complexity of architectural drawing techniques can make it difficult for students to quickly grasp the concepts.
3. Difficulty in Applying Knowledge to Real Projects: Students often struggle to apply theoretical knowledge to real-world architectural projects, which can hinder their practical skills.
4. Limited Access to Materials: Inadequate access to quality learning materials can hinder students' ability to learn effectively.

Addressing Challenges with AutoCAD

AutoCAD addresses these challenges by providing an interactive platform for students to learn architectural drawing techniques, enhancing engagement and practicality. Additionally, AutoCAD's user-friendly interface and tutorials help students quickly grasp the concepts and reduce the learning curve. AutoCAD also enables students to apply theoretical knowledge to real-world projects, enhancing their practical skills. Furthermore, AutoCAD can be accessed from anywhere, making it easier for students to learn and collaborate on projects.

LITERATURE REVIEW

Digital learning media refers to the use of technology in the form of software to distribute information and knowledge to students. The primary purpose of using digital learning media is to enable students to receive knowledge and skills more easily without being constrained by time and space. Digital learning media can be classified into various categories based on their functions, including narrative, interactive, adaptive, communicative, and productive media. These media include podcasting, multimedia presentations, and digital storytelling, which have been shown to be effective in improving students' foreign language competence. The use of digital learning media in higher education has become increasingly prevalent due to the COVID-19 pandemic. Digital media includes social media, smartphones or tablets, videos, wikis, and search engines, which assist in test preparation, support instructional content, and enhance students' self-directed learning

Digital learning media encompasses various forms, including interactive videos, games, and immersive worlds, which provide rich visual perspectives and enable students to experience learning through the eyes of others. Research has shown that digital learning media can support learning in various ways. The effectiveness of these media depends on how they are used in an educational context (Lewis et al., 2019).

Digital learning media serves as a tool that enriches the learning process. It makes learning more interactive, accessible, and flexible, and helps develop students' digital skills and science literacy (Aprilia et al., 2023).

Learning media encompasses various aspects, including definitions, types, theories, benefits, and challenges, which are crucial in understanding its implementation and effectiveness.The following sections provide a detailed description of the various aspects of learning media. This includes definitions, types, theories, benefits, and challenges, which are essential in understanding the complexities of learning media:

Learning media refers to any form or channel used to deliver learning content to learners, which can include various formats such as text, images, audio, video, or a combination of these. Learning media can take various forms, including text, images, audio, video, or a combination of these. These media can be presented through various platforms such as books, the internet, or specialized software.

Learning media can be categorized into several types, each with its unique characteristics and purposes. Print media, for instance, includes books, modules, and worksheets, which provide students with a tangible and accessible source of information. Visual media, such as charts, diagrams, and whiteboards, use visual aids to convey complex concepts and ideas. Audio media, such as voice recordings and podcasts, utilize sound to engage students and facilitate learning. Audiovisual media, including video tutorials and simulations, combine both visual and auditory elements to create an immersive learning experience. Finally, digital media, such as e-learning, mobile applications, and virtual reality (VR), leverage technology to provide students with interactive and engaging learning experiences

Learning media theory encompasses various perspectives that highlight the importance of multimedia, social cognitive, and constructivist approaches in enhancing learning outcomes. According to Mayer's multimedia learning theory, combining words and images in learning can lead to more effective learning outcomes, as it engages learners' visual and verbal processing abilities. Bandura's social cognitive theory emphasizes the role of observation, imitation, and modeling in learning, which can be reinforced through media by providing learners with opportunities to observe and imitate. Constructivist theory, on the other hand, posits that learning is most effective when learners construct their own knowledge from experience, and learning media can facilitate this process by providing interactive and exploratory learning environments

The benefits of learning media are multifaceted and can have a significant impact on the learning process. Firstly, interactive media can increase students' motivation to learn by providing engaging and immersive experiences that capture their attention and interest. This can be particularly effective in subjects like English, where vocabulary learning can be enhanced through the use of pictures and other visual aids. Additionally, visual and audiovisual media can help clarify difficult concepts by providing a more comprehensive and interactive learning experience. Furthermore, digital media allows learners to learn at their own pace and in their preferred learning style, supporting independent learning and personalization. Finally, e-learning can expand the reach of learning by providing access to education at a distance, covering a greater number of learners and increasing the accessibility of educational resources

Challenges in learning media implementation are multifaceted and can significantly impact the effectiveness of educational programs. One of the primary challenges is resource availability, as not all institutions have access to the latest technology or sufficient resources to support learning media. Additionally, teacher and learner readiness are crucial factors, as lack of technical skills from teachers and learners can hinder the effectiveness of learning media. Furthermore, creating engaging and effective educational content takes time and expertise, which can be a significant challenge in developing high-quality learning media. Finally, access and equity issues are a significant concern, as ensuring that all learners have equal access to learning media is a challenge, especially in remote areas where infrastructure and connectivity may be limited

The future of learning media is expected to be shaped by advances in technology, including the use of artificial intelligence (AI), virtual reality (VR), and other adaptive technologies. These advancements will likely enhance the personalization and effectiveness of learning media by enabling the development of content that is more responsive to learners' needs. The integration of big data and learning analytics will also play a crucial role in this process, allowing for the creation of content that is tailored to individual learners. As technology continues to evolve and educational paradigms shift, the study of learning media must also adapt to maximize its potential in supporting an effective learning process

The significance of digital learning media in modern education cannot be overstated, as it has revolutionized the way we teach and learn. The use of digital learning media in modern education has brought numerous benefits. These benefits include improved teaching and learning outcomes, increased student engagement, and enhanced teacher-student interaction. Digital learning media enables students to access information and knowledge more easily, without geographical or temporal constraints. This flexibility allows for both fully digital and blended learning approaches. Digital learning media encompasses a wide range of technological devices, including computers, internet access, servers, televisions, interactive videos, and others. These devices are essential for facilitating digital learning and enhancing the overall learning experience (Menrisal, 2022).

Architectural Drawing Techniques

Architectural drawing techniques are a unique blend of art and science, combining visual ability and creativity with the technical and functional needs of buildings to create a harmonious and functional design. Architects can effectively communicate their ideas through various methods and approaches. This enables them to ensure that the resulting design is not only aesthetically appealing but also functional and sustainable.

The Importance of Architectural Drawing

Detail Engineering Design (DED) drawings or often referred to as working drawings in architecture, have an important role in the design and construction process of a building.

This study aims to examine the effectiveness of using digital learning media using AutoCAD in improving students' architectural drawing skills. Based on these objectives, the hypothesis of this study is that the use of AutoCAD-based digital learning media significantly improves students' architectural drawing skills compared to conventional learning methods.

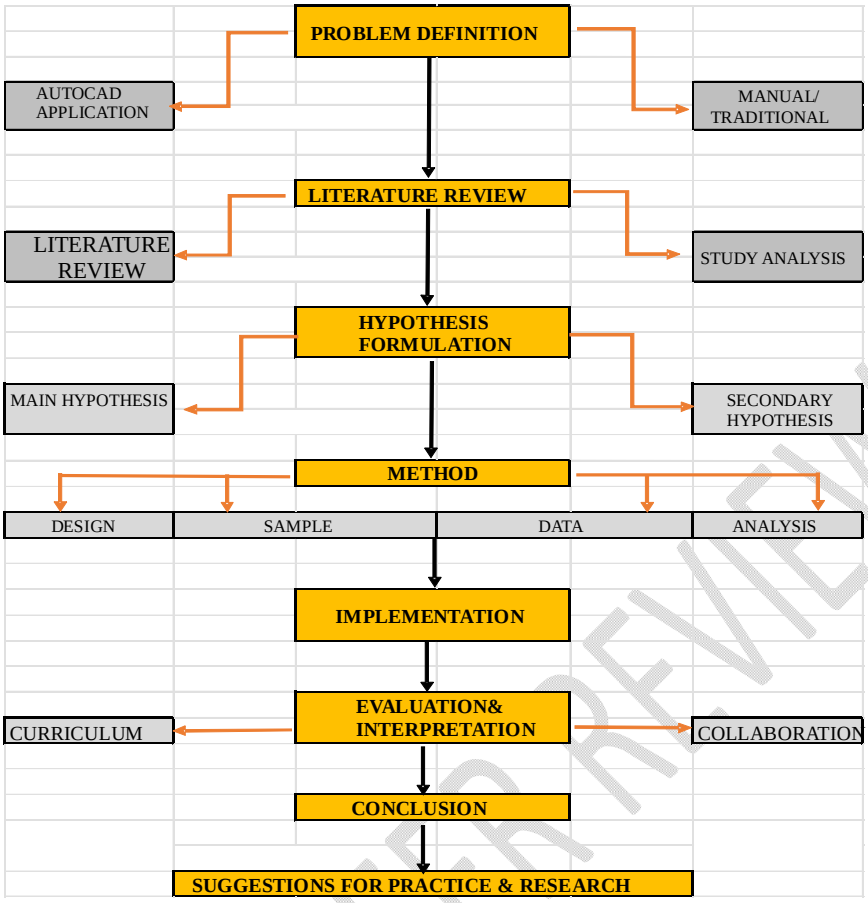

Figure 1. Hypothesis Framework

In research on the integration of the use of AutoCAD as a learning medium in architectural education, the framework describes the theoretical and conceptual relationships between the variables studied. The following is the framework for this research:

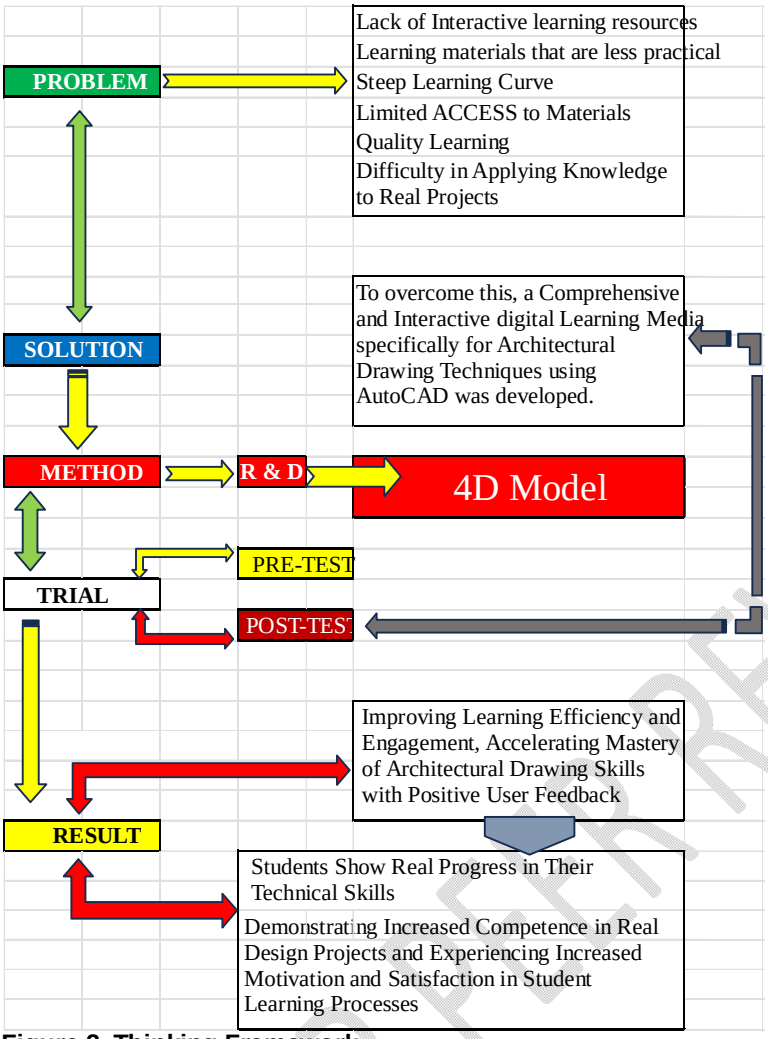

Figure 2. Thinking Framework

RESEARCH METHODS

This research is a type of development research (R&D) that follows the 4D development model (Four-D Model) which consists of four main stages, namely Define, Design, Develop, and Disseminate. This model was developed by Thiagarajan, Semmel, & Semmel (1974) and is often used in the context of learning development.

This research involve students majoring in architecture at Universitas Muslim Indonesia as the main research subject. These students are chosen as subjects because they are a relevant group and represent the target end-users of the developed digital AutoCAD learning media.

The object of this research is the digital AutoCAD learning media to be developed. This media includes various components, including learning materials, interactive modules, design tasks, and evaluation tools integrated in the media.

This research was conducted at the Digital Architecture Laboratory, Department of Architecture, Faculty of Engineering, Universitas Muslim Indonesia.

In the context of research on AutoCAD digital learning media design for architectural drawing techniques, the following are proposed subjects and objects of relevant research:

Research subjects are individuals or groups that will be directly involved in the research. In this case, research subjects may include:

a. Architecture student.
b. Lecturer in Architecture:
c. AutoCAD Instructor

To develop an effective learning media design, it is important to have good data analysis techniques. Here are some relevant data analysis methods to assess the validity, practicality, and effectiveness of AutoCAD digital learning media for architectural drawing techniques:

To assess the effectiveness of the learning media:

a. Analysis of Pre-Test and Post-Test: Using statistical tests to measure performance improvement after using the learning media.
b. Paired T-Test:

$$t = \frac{\bar{D}}{\frac{S_D}{\sqrt{n}}}$$

where:
- $\bar{D}$: Average difference between pre-test and post-test
- S_D: Standard deviation of difference
- n : Number of participants

c. Gain Test: To see the relative improvement between pre-test and post-test.

$$G = \frac{\boldsymbol{S}post - \boldsymbol{S}pre}{\boldsymbol{S}max - \boldsymbol{S}pre}$$

where:
- Spre: Pre-test score
- Spost: Post-test score
- Smax: Maximum score that can be obtained

This analysis will help to get a clear picture of the quality of the learning media, including whether it meets users' needs and enhances learning effectively.

The research model that used in this research is the 4D Development Model (Four-D Model) which consists of four main stages: Define, Design, Develop, and Disseminate. This model will provide a systematic guide to design, develop, and evaluate digital AutoCAD learning media in architectural drawing techniques.

By following the 4D development model, this research will ensure that the development of digital AutoCAD learning media in architectural drawing techniques is carried out systematically and can provide effective results and in accordance with the learning needs of architecture students at Universitas Muslim Indonesia.

The study could benefit from more detailed descriptions of the procedures and techniques used at each stage of the 4D model. This would enhance the transparency and rigor of the study by providing a clear understanding of how the research was conducted.

The selection criteria for research subjects should be clearly stated. This includes the rationale behind choosing architecture students from Universitas Muslim Indonesia as the main research subjects. Providing this information would add to the transparency and credibility of the study.

The study could strengthen its evaluation of the learning media's effectiveness by incorporating more robust data analysis methods beyond basic statistical tests. This could include techniques such as regression analysis or factor analysis to better understand the relationships between variables.

The study should explicitly state how it adheres to ethical guidelines and safeguards participant rights. This is crucial for ensuring the integrity and credibility of the research, particularly when involving human subjects.

By addressing these areas, the study can enhance its methodology and provide a more comprehensive and rigorous evaluation of the digital AutoCAD learning media. This would contribute to a more robust understanding of the effectiveness of these media in improving architectural drawing skills and provide valuable insights for future research and educational practices.

RESEARCH RESULTS AND DISCUSSION

Research Results

The research results obtained are as follows:

Research Results on the Effectiveness of Digital Learning Media Design for Architectural Drawing Techniques Using Autocad

Based on the observation and calculation of N-Gain Score for pre-test and post-test, here is the full description:

Table 1. Learning Media Effectiveness Results

No.	Student Name	Pre-Test	Post Test	Post-Pre	Ideal Score (100-Pre)	N-Gain Score	N-Gain Score (%)
1	Ahmad Yasin	65	95	30	35	0.857	85.71
2	Andi Fadli Renaldi	70	96	26	30	0.867	86.67
3	Haerul Asrori	72	94	22	28	0.786	78.57
4	Jukrianto	68	97	29	32	0.906	90.63
5	Mohammad Sawali	66	95	29	34	0.853	85.29
6	Muh Akhyar Al-Ansari	74	98	24	26	0.923	92.31
7	Muh. Imam Anugrah	69	97	28	31	0.903	90.32
8	Muh.Asdar	71	99	28	29	0.966	96.55
9	Muhammad Fakhrurrozi	67	96	29	33	0.879	87.88
10	Muhammad Rifqy Kamaruddin	73	95	22	27	0.815	81.48
11	Muhsin Haeruddin	70	98	28	30	0.933	93.33
12	Nazar	64	94	30	36	0.833	83.33
13	Nurfazilayanti	75	97	22	25	0.880	88.00
14	Nurhakim Sabir	62	95	33	38	0.868	86.84
15	Nurziana binti azmain	78	96	18	22	0.818	81.82
16	Raihan Ardana Ramadhan	68	94	26	32	0.812	81.25
17	Rangga Aditya Trianto	76	95	19	24	0.792	79.17
18	Sulthon Muhammad Adjie	74	98	24	26	0.923	92.31
19	Virgian Listianto Endi	69	97	28	31	0.903	90.32
20	Yusrivaldi Rivai	73	99	26	27	0.963	96.30
21	Yusul Ali Imran	71	95	24	29	0.828	82.76
MEAN		70.24	96.19	25.95	29.76	0.872	87.18

This study involved 21 students who took the pre-test and post-test in learning architectural drawing techniques using AutoCAD. The data collected included pre-test scores, post-test scores, and N-Gain Score calculations to measure the effectiveness of the learning media used.

It is important to note that all students experienced improved learning outcomes, with the lowest N-Gain Score still above 79%. This indicates that none of the students did not benefit from learning using AutoCAD digital media. The average improvement of 25.95 points from pre-test to post-test shows that this teaching method is very effective in improving students' architectural engineering drawing skills.

The study demonstrates a significant improvement in students' architectural drawing skills through the use of AutoCAD digital learning media. All 21 students showed enhanced learning outcomes, with an average N-Gain Score of 87.18%, indicating the effectiveness of the teaching method.The substantial average improvement of 25.95 points from pre-test to post-test underscores the efficacy of incorporating digital media in architectural education.Future research should focus on larger scale testing to validate the effectiveness of the digital learning media. Additionally, content development should cover a wider range of architectural design aspects to ensure the learning media remains relevant and comprehensive.The study suggests that there is a need for further integration of digital technologies in the architecture curriculum to enhance learning outcomes.Students provided positive feedback on the interactivity and practicality of the learning media, indicating their satisfaction with the learning experience.

DISCUSSION

The study involved 21 students who took the pre-test and post-test. Results showed a significant increase in the mean score from 70.24 (pre-test) to 96.19 (post-test). The average N-Gain Score of 87.18% indicates a high increase in learning outcomes. All students experienced improvement, with the lowest N-Gain Score still above 79%, indicating that AutoCAD digital learning media is very effective in improving students' understanding and architectural engineering drawing skills.
The conclusion is that the developed AutoCAD digital learning media meets the needs of students and is effective in improving architectural engineering drawing skills. High content validity, practicality in implementation, and significant improvement in learning outcomes indicate that this media can be used as an effective learning tool in the context of architectural education.

CONCLUSIONS

Based on the Research Results of the Effectiveness of Digital Learning Media Design for Architectural Drawing Techniques Using Autocad. This study involved 21 students who took the pre-test and post-test in learning architectural drawing techniques using AutoCAD. Results showed a significant increase in the mean score from 70.24 (pre-test) to 96.19 (post-test). The average N-Gain Score of 87.18% indicates a high increase in learning outcomes. All students improved, with the lowest N-Gain Score still above 79%.
The effectiveness is proven by the increase in the average score from 70.24 (pre-test) to 96.19 (post-test) and the average N-Gain Score of 87.18%, indicating that this learning media is very effective in improving student skills.

Disclaimer (Artificial intelligence)

Option 1:

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

Option 2:

Author(s) hereby declare that generative AI technologies such as Large Language Models, etc have been used during writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology

Details of the AI usage are given below:

1. DeepL (Translator)

2.

3.

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