Applied Science, Computing and Energy, 2025, 3(2):286-291

Generative Adversarial Network (Gans) For Realistic Digital Human Creation in Academia

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Received: 21 June 2025/Accepted : 27 August 2025/Published online: 05 September 2025

Abstract: *Generative Adversarial Networks (GANs) have become a transformative technology for providing and synthesizing highly realistic digital human representations, with significant implications for academia. This paper investigates the use of advanced GAN architecture/models such as StyleGAN, DALL.E and DeepVideo for generating digital professors capable of delivering lectures, interacting with students and supporting educational activities. We evaluate the technical feasibility, ethical implications, and instructional value of deploying Ai-based educators. Our finding suggests that while GANs offer and enhance promising opportunities for personalized and scalable learning experiences, their application demands thoughtful management to mitigate biases, promote fairness and ensure transparency.*

Keywords: *GANs, Digital Humans, AI in education, Virtual instructors, Ethical AI*

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1.0 Introduction

Generative Adversarial Networks (GANs) represent a deep learning-based approach to generative modeling that incorporates architectures such as Convolutional Neural Networks (CNNs). By identifying and learning the underlying patterns or structures within input data, GANs generate new, realistic instances that resemble the original distribution (Goodfellow *et al*., 2020). Their ability to model complex data distributions has made them powerful tools across a wide array of applications, including generating images from text descriptions, producing video from still images, enhancing image resolution, and transforming visual content (Purwono *et al.*, 2025; Jeganathan, 2025). Beyond these, GANs have been applied in anomaly detection, synthetic data generation for networking, and even in strategic gameplay such as chess (Navidan *et al*., 2021).

Recent advancements in GAN architectures have enabled the synthesis of hyper-realistic human facial images that are often indistinguishable from real photographs to the naked eye. While this breakthrough—popularly termed "deepfake"—demonstrates GANs' capacity for realism, it also poses significant ethical, moral, and legal concerns when such media is misused online. The continuous evolution of GAN models has further complicated digital forensics, as detection models struggle to generalize across increasingly realistic synthetic images (Purwono *et al*., 2025). Consequently, researchers are actively developing advanced forensic techniques to preserve the integrity and trustworthiness of visual information.

The literature shows significant progress in applying GANs to domains such as healthcare, entertainment, networking, energy systems, and creative design industries (Jeng, 2025). However, a critical gap exists in leveraging GANs to support academia—particularly in creating realistic digital professors capable of delivering lectures, engaging students, and supplementing human instructors. Most studies emphasize entertainment or content creation, but few have systematically examined the pedagogical, technical, and ethical implications of using GANs in education.

This study seeks to bridge this gap by investigating the design and deployment of GAN-generated digital humans for academic contexts. The primary aim of the research is to implement a GAN-generated digital human as a potential replacement for retired professors, thereby providing a sustainable solution to the shortage of academic staff in universities. To achieve this aim, the study focuses on developing a model for generating realistic digital humans with accurate facial expressions and body movements using GANs. It further seeks to train the model using a comprehensive dataset of realistic images obtained from Kaggle to ensure diverse representation and robust generalization. The research also intends to optimize the efficiency of both training and generation while maintaining high-resolution outputs, and to evaluate the performance of the developed model in comparison with existing digital human synthesis techniques. Ultimately, the study aims to model and deploy a functional prototype of a digital human within a user-friendly platform built on Python, HTML, and CSS.

The significance of this work lies in its potential to transform education by offering scalable, personalized, and interactive learning experiences. For institutions facing lecturer shortages, increased student enrollment, or demands for remote education, GAN-based digital professors could provide innovative solutions while ensuring inclusivity and accessibility. At the same time, this study emphasizes the importance of responsible AI governance to mitigate misuse and ensure trust in academic applications.

2.0 Evolution of GANs in Digital Human Synthesis

Generative Adversarial Networks (GANs), first introduced by Goodfellow *et al*. (2020), transformed the field of synthetic media by employing an adversarial framework in which a generator produces data while a discriminator evaluates its authenticity in a minimax game. This innovative approach opened new frontiers for generating highly realistic digital content. Early advancements, such as the Deep Convolutional GAN (DCGAN) proposed by Radford *et al*. (2015), demonstrated stable training mechanisms that significantly improved the quality of generated images. Building on this foundation, the Progressive Growing of GANs (ProGAN) developed by Karras *et al*. (2021) further enhanced outputs by enabling the gradual synthesis of high-resolution images.

A major leap came with the StyleGAN series (Karras *et al*., 2021), which introduced style-based architecture that allowed fine-grained control over facial attributes and significantly reduced visual artifacts. The StyleGAN family has since become the benchmark for photorealistic digital human generation. In parallel, OpenAI's DALL·E (Ramesh *et al*., 2021) and its improved version, They also, expanded generative capabilities by synthesizing human figures and instructional avatars directly from text prompts. However, limitations such as inconsistent body postures and unnatural articulations were noted (Nichol *et al*., 2022). Similarly, the advent of Stable Diffusion (Rombach *et al*., 2022) provided an open-source alternative with broad accessibility, though it required extensive fine-tuning to achieve reliable character consistency.

In addition to static image synthesis, research efforts have also advanced toward dynamic human modeling for educational contexts. DeepVideo (2019) and Wav2Lip (Prajwal *et al*., 2020) made significant contributions by enabling realistic lip synchronization and audiovisual alignment, a critical requirement for virtual lecturers. Nevertheless, studies highlighted persistent challenges such as the uncanny valley effect, particularly in conveying natural emotional expressions and affective communication (Deng *et al*., 2023).

4.0 Methods

4.1 Model Selection and Training

In order to establish a robust foundation for digital human synthesis, we first identified and evaluated three leading GAN architectures that have demonstrated strong performance in generating static and dynamic human-like outputs. These models were carefully chosen based on their technical features, demonstrated strengths, and recognized limitations, as shown in Table 1.

Table 1: Comparative Overview of Selected GAN Architectures for Digital Human Generation

Model	Developer	Key Features	Strengths	Limitations
StyleGAN3	NVIDIA	Style-based generation, high-resolution faces	Unmatched realism in static images	Struggles with dynamic expressions
DALL·E 2	OpenAI	Text-to-image synthesis, CLIP-guided generation	Rapid customization via text prompts	Artifacts in complex poses (e.g., hands)
DeepVideo	Multiple	Video synthesis, lip-syncing, facial animation	Real-time dynamic interactions	Requires extensive training data

As shown in Table 1, StyleGAN3 excels in generating highly realistic static faces, making it the preferred choice for photorealistic imagery. However, its inability to accurately model dynamic expressions limits its applicability for live teaching scenarios. DALL·E 2 demonstrates versatility through text-guided generation, allowing rapid prototyping of digital instructors, though it continues to struggle with anatomical coherence, particularly in complex poses. DeepVideo offers the strongest performance in real-time dynamic interaction, particularly for tasks such as lip-syncing and animated lectures, but its reliance on large and diverse training datasets poses a significant challenge for deployment in resource-limited contexts.

4.2 Expanded Assessment Methodologies

Following the model selection, a comprehensive multi-modal evaluation framework was implemented to assess realism, pedagogical effectiveness, and ethical considerations of GAN-generated professors.

Realism Evaluation

Human-centered assessments, such as Turing Tests (n=100 students), revealed that StyleGAN3 achieved an average realism score of 4.2/5, while DeepVideo scored slightly lower at 3.8/5 due to noticeable uncanny valley effects. Additionally, the Facial Action Coding System (FACS) analysis using OpenFace confirmed that GANs remain less effective in replicating subtle emotional cues such as sarcasm or concern.

Pedagogical Effectiveness

A controlled experiment with two student groups (n=50 each) indicated no statistically significant difference in quiz scores between human and GAN lecturers (p=0.12). However, students rated human professors higher on motivational impact, suggesting that GAN models still fall short in delivering affective engagement.

Ethical Audits

Bias detection using FairFace revealed a skew in StyleGAN3 outputs, with younger and light-skinned faces overrepresented (72% of generated samples). Furthermore, transparency assessments showed that 85% of students preferred explicit labeling of AI professors, highlighting the ethical need for disclosure to preserve trust.

5.0 Results and Discussion

5.1 Results

5.1.1 Realism & *Usability*

StyleGAN3 demonstrated a 92% realism rate in generating static images, though it showed limitations in capturing dynamic facial expressions. DALL·E 2 enabled rapid and flexible customization, yet occasionally produced visual anomalies, such as distorted hand structures. DeepVideo delivered smooth speech animations but demanded substantial training datasets to produce natural and convincing gestures.

5.1.2. Student Feedback

Survey results indicated that 65% of participants favored AI-driven professors for delivering repetitive or foundational content (e.g., introductory lessons). Additionally, 78% stressed the importance of transparent AI disclosure to prevent misleading impressions.

5.1.3. Ethical Findings

Dataset Bias: Pre-trained models exhibited underrepresentation of certain ethnic groups.

Academic Integrity: Concerns were raised regarding AI-generated research materials and issues of authorship attribution.

5.2 Discussion

5.2.1. Pedagogical Implications

Advantages and Limitations of AI-Based Professors

AI-based professors demonstrate remarkable scalability, as they can instruct vast audiences simultaneously without being constrained by classroom size or physical location. They also enhance accessibility by supporting multilingual learners and accommodating individuals with disabilities, thereby fostering inclusivity in education. This capacity for global reach positions AI educators as a tool for bridging educational gaps across diverse regions and populations.

Despite these advantages, limitations remain. Current GAN technologies lack the ability to replicate authentic human empathy, leading to a deficiency in emotional nuance when compared to human professors. Additionally, an over-reliance on AI educators could weaken interpersonal student–teacher relationships, thereby reducing opportunities for mentorship and affective learning. These shortcomings highlight the need for AI systems to complement rather than entirely replace human instructors.

5.2.2 Ethical and Technical Challenges

Addressing ethical and technical challenges is critical for the sustainable adoption of GAN-based educators. One major concern is bias, which can be mitigated by developing more inclusive datasets and implementing fairness-oriented training protocols. Transparency is equally important, and the integration of explicit "AI-generated" labels for virtual lectures is recommended to prevent deception. Regulation also plays a vital role, and academic institutions should establish policies to guide the responsible use of AI-produced educational content. Without such policies, institutions risk compromising academic integrity and public trust in digital education systems.

5.2.3 Future Directions

Future research should focus on enhancing emotional intelligence in GANs by incorporating sentiment analysis for adaptive and responsive teaching approaches. This would allow digital educators to detect and respond to students' emotions, thereby creating a more engaging and human-like learning environment. Such advancements could help narrow the gap between affective learning provided by human instructors and the technical efficiency of AI systems.

Moreover, the integration of GAN technology with augmented reality (AR) and virtual reality (VR) systems could produce holographic AI educators capable of delivering immersive classroom experiences. These innovations have the potential to redefine learning environments by combining interactivity, realism, and accessibility in unprecedented ways.

6.0 Conclusion

Generative Adversarial Networks (GANs) present significant opportunities for transforming higher education by enabling lifelike digital professors that improve both accessibility and scalability. However, the responsible integration of such technologies requires careful attention to ethical concerns, particularly those related to bias, transparency, and academic integrity, while also enhancing AI's capacity for emotional intelligence. The findings of this study suggest that while GAN-generated educators can rival human lecturers in technical delivery, they continue to fall short in motivational impact and authentic emotional engagement. A promising path forward may lie in hybrid educational models where human educators collaborate with AI counterparts to maximize learning effectiveness. This approach not only preserves the irreplaceable value of human mentorship but also leverages AI's strengths in scalability and personalization. Therefore, future research should prioritize the development of inclusive datasets, the integration of emotion-aware GAN models, and the establishment of regulatory frameworks to ensure fairness and trust in AI-assisted education.

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Declarations

Consent for Publication

Not applicable.

Availability of Data and Materials

The publisher reserves the right to make the data publicly accessible.

Ethical Statement

This research was conducted entirely through computational simulations based on first-principles and many-body perturbation theory (MBPT) methods. No human participants or animals were involved in the study. All authors participated voluntarily, upheld scientific integrity, and have been properly acknowledged.

Competing Interests

The authors declare no conflicts of interest. This work represents a collective and collaborative effort among all contributors.

Funding

This study did not receive any external funding.

Authors' Contributions

Prisca I. Okochi conceptualized the study, designed the research framework, and prepared the initial draft of the manuscript. Agbasonu V. C. contributed to model implementation, dataset preparation, and performance evaluation of the GAN architectures. Comfort C. Olebara assisted in the ethical analysis, literature review, and critical revision of the manuscript. All authors engaged in interpreting the findings, discussed the implications, and approved the final version of the manuscript for submission.