Artificial Human Lecturers: Initial Findings from Asia's First AI Lecturers in Class to Promote Innovation in Education

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Abstract. In recent years, artificial intelligence (AI) has become increasingly integrated into education, reshaping traditional learning environments. Despite this, there has been limited investigation into fully operational artificial human lecturers. To the best of our knowledge, our paper presents the world's first study examining their deployment in a real-world educational setting. Specifically, we investigate the use of "digital teachers," AI-powered virtual lecturers, in a postgraduate course at the Hong Kong University of Science and Technology (HKUST). Our study explores how features such as *appearance*, *non-verbal cues*, *voice*, and *verbal expression* impact students' learning experiences. Findings suggest that students highly value *naturalness*, *authenticity*, and *interactivity* in digital teachers, highlighting areas for improvement, such as *increased responsiveness*, *personalized avatars*, and *integration with larger learning platforms*. We conclude that digital teachers have significant potential to enhance education by providing a more *flexible*, *engaging*, *personalized*, and *accessible* learning experience for students.

Keywords: Artificial Intelligence (AI) · Artificial Human Lecturers · Education · Human-AI Interaction

1 Introduction

The global teacher shortage is a critical issue, with UNESCO predicting a need for an additional 44 million teachers by 2030, including 17 million in Sub-Saharan Africa alone [3]. Economic disparities worsen this situation, as many low-income countries spend less than 3% of their GDP on education, leading to low salaries that drive teachers, especially in places like Zimbabwe, to seek better opportunities abroad [13]. Additionally, the World Bank expects a 30% increase in student

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enrollment in the Middle East and North Africa by 2030, requiring more qualified educators [30]. Retention is also a challenge, with nearly 50% of new teachers leaving within five years due to high workloads and lack of support [19]. In the US, 8% of teachers leave annually [1], while over 32,000 educators left Korea before retirement [18], and 43,500 teachers left the UK state-funded education system in 2022–2023 [2].

These issues highlight the urgent teacher shortage, leading us to ask: **How can modern technology help address the short-staffed education sector?** To explore this, we conducted a study using 10 pairs of AI-powered digital lecturers in a graduate course, collecting data from 26 students and interviewing 15 participants.

Our research is important for three reasons: it offers strategies for integrating digital teachers into education, provides an AIGC (Artificial Intelligence Generated Content) framework for digital educators, and introduces Asia's first "AI Lecturers" in classrooms, promoting teaching innovation with over 150 media coverage.

However, we faced challenges such as limited VR headsets and participant availability, along with technological issues in creating effective AI lecturers. Individual differences in perception also complicate user acceptance. Addressing these challenges is crucial for solving the global teacher shortage.

To understand students' views on digital instructors, we used the Technology Acceptance Model (TAM) [10] and identified four key criteria that influence perceptions: (i) Appearance and Character Choice, (ii) Non-verbal Cues, (iii) Voice and Verbal Expression, and (iv) Variety and Novelty. These factors are essential for user acceptance and engagement, affecting initial impressions, communication, clarity, and the overall engagement of the digital teaching experience. We will focus our analysis on two research questions.

- **RQ1:** How does the variation of the four parameters in digital teachers impact students' experiences?
- **RQ2:** According to students, what are the potential areas for improvement in the implementation of digital teachers, and how do they view the future of digital teachers in education?

Our findings reveal that variations in these parameters significantly influence students' experiences. Participants expressed optimism about digital teachers, recognizing their potential to enhance traditional teaching methods. However, concerns regarding AI lecturers were also noted, particularly around the need for personalized interactions and flexibility for diverse learning styles. Overall, students view digital instructors as valuable tools for creating inclusive and dynamic learning environments.

In the following sections, we review literature on educational technologies and "digital humans." We then describe the technology and design of our AI lecturers. Our qualitative approach, mainly in-depth interviews, to capture general perceptions and gain deeper insights. The findings will suggest future digital teaching efforts, focusing on improving access to education for marginalized communities

and MOOC platforms. This study is a pioneering effort in AI digital instruction in higher education, attracting significant media attention and promoting further research and innovation in digital education.

2 Background and Related Work

2.1 Existing Pedagogical Practices and Transformation

A lot of research shows that effective teaching needs to move away from traditional, teacher-centered methods. In higher education, students are losing trust in these outdated approaches [6] and are less interested in learning methods they see as obsolete [12]. The discussion contrasts common teaching methods based on tradition with expert teaching based on empirical knowledge [26]. Research highlights that teachers' attitudes are vital for effective teaching [7]. Modern education views students as active participants rather than passive recipients of knowledge.

Constructivist approaches, such as those by Vygotsky [29] and Persson [26], encourage students to explore and ask questions, forming the basis for current educational shifts. These approaches emphasize active participation, social interaction, and strong teacher-student relationships [12]. Instead of traditional lectures, teachers now act as facilitators, helping students build their own understanding.

Constructivist assessment methods include discussions, hands-on activities, and KWL(H) charts [22]. However, some critics argue that there isn't enough evidence supporting constructivism's effectiveness and claim it can be problematic for beginners [27]. Despite this, constructivism has inspired popular learning methods like discovery and problem-based learning, shaping modern educational practices.

Today's teaching increasingly adopts a student-centered approach. Research suggests that effective teaching relies more on humanistic pedagogy than on just subject expertise [7]. These teaching methods are often criticized for their effectiveness, with no single "perfect" approach. A balanced method that combines traditional and innovative practices is recommended to enhance the educational experience [4]. Understanding modern teaching methods alongside technology is essential.

2.2 Learning with Technologies

The integration of technology has changed traditional teaching. It has improved classroom effectiveness by fostering student-centered learning and enhancing teacher-student relationships [28]. Digital tools have opened new opportunities for engagement and collaboration [17]. Research shows that using technology can lead to better academic performance compared to traditional methods [5].

The shift to online learning due to the COVID-19 pandemic has highlighted technology's importance in education. The GPT models are influencing various sectors, including education. Researchers are exploring how generative AI can

enhance education through applications like educational games and chatbots [14,15]. While chatbots show potential for improving education, they also have limitations [24]. Concerns about the ethical implications of using generative AI in education have been raised, emphasizing the need for effective guidelines [8,9].

Immersive technologies, especially the Metaverse, are also becoming significant in education [11]. Studies show that virtual reality can improve learning outcomes in various subjects [25]. Immersive technologies are being developed for diverse educational contexts.

Digital humans, or avatars, are key components of immersive technologies [21]. Early attempts to use virtual humans in education have shown promise in teaching interpersonal skills. Further studies indicate that AI digital humans can enhance language learning and create inclusive environments. Avatars can also foster community and motivation in learning contexts [16].

In conclusion, advanced technology can personalize learning experiences. Research supports the effectiveness of immersive education in STEM fields [20], raising the question of how educators can best use these technologies to improve teaching and learning experiences.

3 Methodology

This section describes our participants' recruitment process, class and study arrangement, participants, data collection, and analysis.

3.1 Participant Recruitment

Recruitment Process. Before we began our courses and research, our university's Institutional Review Board (IRB)[1] approved our work to ensure that it complied with all ethical guidelines and procedures related to human subject research. In view of the special context of our study, the research methods should be grounded in the facticity and applicability of actual higher-education scenarios. Following IRB approval, the study ran through a semester-long postgraduate course, beginning with our university's typical course registration process using convenience sampling techniques.

The advantages of involving student participants lie primarily in its relevance and authenticity. Thus, students' insightful comments and feedback on digital teachers' viability, acceptability, and practical implementation align with our goals. Meanwhile, challenges with this approach are generally due to its voluntary nature. Participating in research activities may disrupt students' normal learning and classroom experiences. Therefore, researchers employed regular refinement through rigorous pilot testing, providing transparent communication and expectation setting to minimize bias and disruption to the student's regular learning experiences (to the best of our capability). Most importantly, all participants in this study were voluntary and could withdraw at any time during any of the ten weeks. They were free to decline at any point or to not respond to any question for any reason.

[1] Protocol number: HREP-2024-0018.

Recruitment Considerations. Participants were required to be current students and on a first-come, first-served basis. Since this cross-campus course targeted an interdisciplinary background, we welcomed all students from different faculties. As the number of head-mounted displays (HMDs) is limited in the two campuses, the recruitment quota varied. The number and information about the participants will be further reported in 4.3 Participants.

3.2 Class and Study Arrangement

To ensure quality teaching in the postgraduate course CMAA5022/EMIA6500F Social Media for Creatives, we conducted weekly 60–90 min rehearsals with two research assistants, four teaching assistants, and researchers.

The course utilized a hybrid teaching approach that combined digital and human lecturers, inviting students to explore social media platforms, content creation strategies, and generative AI technologies (see Fig. 1). Key topics included digital storytelling, gamification, immersive technologies, and relevant research skills, emphasizing exploration and creativity. The integration of digital teachers enhanced accessibility, and the curriculum was approved by senior academic staff to ensure alignment with educational standards.

(a) Course photo in one of the campuses.

(b) Course leader was introducing our digital teacher.

(c) Course photo in the other campus.

Fig. 1. This is a cross-campus graduate-level course held simultaneously on both campuses every week. Digital teachers met with students in different formats.

This cross-campus course, scheduled for Spring 2024, consists of three hours of instruction per week. Approximately 30 min of each lecture is dedicated to explanatory content covering social media terminology, while 60 min focuses on case studies and theoretical knowledge. The remaining time includes paper presentations, in-class discussions, and hands-on tutorials led by teaching assistants, interspersed with breaks of 5–15 min.

Due to the collaborative nature of the course, students and teaching teams were spread across both campuses, with all lectures recorded and live-streamed via Zoom. After discussions with senior staff and feedback from a pilot study, it was decided that digital teachers would cover a quarter of the teaching materials in each class to maintain interactivity. The study took place over ten weekly

lectures from January 23 to April 16, 2024, with each session lasting 30 min and showcasing different digital teaching styles.

Inspired by the MUD card method [23], participants provided feedback via Qualtrics after each section, ensuring the voluntary nature of participation through informed consent. In the eleventh lecture, students ranked the digital teachers and had the option to participate in in-depth voluntary interviews, emphasizing the discretionary nature of their involvement. This approach combined the comparison on teachers' rankings with qualitative insights to enhance understanding of participants' experiences and perceptions regarding the effectiveness and value of the digital teacher applications.

3.3 Participants

Our study involved 27 students, of whom 2 withdrew and 1 later rejoined, resulting in a final participant count of 26, designated as P1 through P26. The cohort consisted of 12 females, 13 males, and 1 participant who preferred not to disclose gender. Participants primarily came from diverse professional backgrounds, with 9 in computer science, machine learning, engineering, and science-related fields, 6 in art and design, and the remainder enrolled in interdisciplinary programs. Participants self-identified their expertise, with 13 labeling themselves as "Technician/Engineer" (5 females) and 10 as "Designer/Artist" (4 females), while 3 opted not to disclose their professional backgrounds. Geographically, the majority of participants hailed from Mainland China (25 participants, 12 females), with 1 participant from Egypt. Participants' ages ranged from 18 to 45, with an average age of 26 years (SD: 5.21), distributed across three cohorts: 13 participants aged 18–25, 12 aged 26–35, and 1 aged 36–45.

Prior to the study, all participants were familiar with digital human applications, mainly through entertainment. Notable virtual icons mentioned included Luo Tianyi (18 mentions), Barbie (8), Kizuna AI (3), AYAYI (3), and others, indicating a strong recognition of digital humans in social media contexts.

The above summarizes demographic data for students in the class. As mentioned, our study strongly counts on these interviews. The following section illustrates the data collection process and highlights the details of our in-depth interview.

3.4 Data Collection

The interviews aimed to: (i) study how different digital teacher styles affected students' views and experiences; (ii) see how students' backgrounds influenced their acceptance of digital teachers; (iii) explore how digital teachers changed teaching methods in higher education; and (iv) allow participants to design their ideal digital teacher in a workshop setting.

Among the 26 participants in class, 15 volunteered for interviews (P1-P15), comprising 8 males and 7 females, with 4 identifying as designers/artists and 11 as technicians/engineers. Table 1 shows the participants' demographic and their preferences collected from the post-lesson survey.

Table 1. An overview of the semi-structured interview participants' demographics and preference on digital teachers after the 10 weeks experiences

ID	G	Platform	Expertise	Age Group	Best Teacher	Most Valued Feature	Interest in Digital Human Application(s)
1	F	F2F	TE	18–25	Einstein	Format	Yes, occasionally
2	F	F2F	TE	26–35	Fiona	Style and Design	Yes, occasionally
3	F	F2F	DA	18–25	Fiona	Style and Design	No, but I'm interested in trying it
4	F	F2F	DA	18–25	Camilla	Non-verbal Cue	Yes, occasionally
5	F	F2F	TE	18–25	Fiona	Non-verbal Cue	Yes, occasionally
6	M	F2F	TE	18–25	Einstein	Format	No, but I'm interested in trying it
7	F	F2F	DA	26–35	Fiona	Style and Design	No, but I'm interested in trying it
8	M	F2F	TE	26–35	Fiona	Non-verbal Cue	Yes, frequently
9	M	F2F	DA	26–35	Fiona	Non-verbal Cue	Yes, frequently
10	M	F2F	TE	18–25	Ben	Format	Yes, occasionally
11	M	F2F	TE	26–35	Ben	TQC	Yes, frequently
12	M	F2F	TE	18–25	Idol Aria	Format	Yes, occasionally
13	M	Zoom	TE	36–45	Ben	Style and Design	Yes, occasionally
14	F	Zoom	TE	26–35	Gabriela	Format	No, but I'm interested in trying it
15	M	F2F	TE	18–25	Einstein	TQC	Yes, occasionally

Our flexible interview methodology ensures the open and inclusive expression of ideas. For individuals who preferred not to conduct in-person interviews, we accommodated them with online interviews (n = 2) via Zoom. The interviews with other participants were mainly conducted in the campus and arranged in accordance to their schedules (n = 13). Furthermore, Interviews were performed in the participants' native tongue, mainly Mandarin (n = 14) and English (n = 1) to ensure their comfort, allowing for free and unrestricted idea expression.

The data collection process for the interviews was from the 17th of April 2024 to the 31st of May 2024. Each interview lasted between 50 and 75 min, typically in a meeting room, with posters and all digital teachers' screenshots showcased to recall the learning experiences (see Fig. 2). After the brief warmup and overview, each interview question was subject to individuals' answers according to the former survey results under the same structure. Interviews were also audio-recorded with participants' permission. The worksheets were collected under participants' consent to formulate the ideal digital teachers and their future vision (see Fig. 2).

To ensure accurate transcripts and translations, each recording was first transcribed using the iFlytek transcription tool and then manually verified by at least two researchers. Translation was done simultaneously by three native Chinese-speaking researchers to maintain language accuracy. Researchers rewrote, rephrased, and corrected any transcription errors or unclear sentences. They compared the three translations and agreed on a final version through discussion. To further validate accuracy and preserve the essence of the interviews, researchers used ChatGPT 4 to create a polished version of the text, removing repetitive and irrelevant information. The final analysis was based on agreed lexical choices, comparisons between the simplified and original texts, and considerations of the participants' cultural backgrounds and ages. Overall, the data collection process followed systematic and detailed procedures.

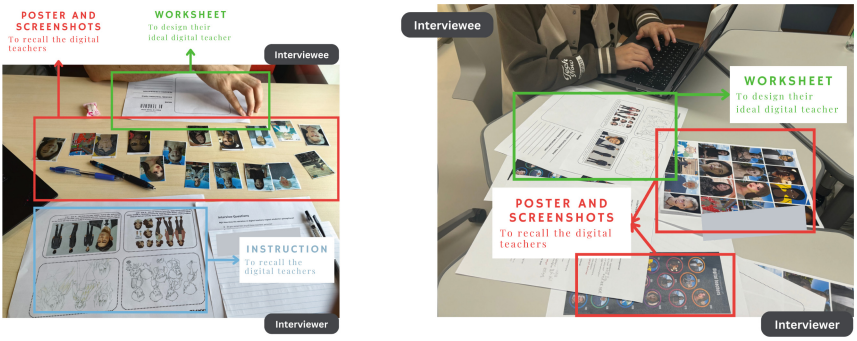

Fig. 2. Interview and its setup in the study.

3.5 Data Analysis

The study employed a qualitative approach in data collection and analysis. The qualitative component (which is the core part of this manuscript) consisted of semi-structured interviews with 15 volunteer participants from the course. Only a small amount of quantitative components involved with the survey of 26 students to assess their rankings and ratings of the digital teachers. While the data collected from each survey was tabulated and compared to identify patterns and trends in the students' perceptions of different digital teachers, our data analysis focuses on the data collected from the semi-structured interviews.

The semi-structured interviews were transcribed and subjected to inductive analysis. The researchers, comprising two postgraduate students and a postdoctoral research fellow, held weekly meetings via Zoom to perform the systematic qualitative data analysis using the collaborative whiteboard tool named Miro[2]. The analysis involved creating affinity diagrams and engaging in in-group discussions to identify emerging themes, patterns of perception, and primary concepts in potential improvement or future direction.

Refinements were made over two months of discussions, allowing us to improve the material. We specifically enhanced the groupings and naming conventions. For instance, "realism and credibility" was initially a separate theme for key factors in RQ1, but we found it overlapped with other groups. After discussion, three researchers agreed to integrate these concepts into other main themes. Another important change was renaming a defined pattern; "Enhancing the Interactive Elements" was changed to "Situation-Aware Interactivity" to better align with the context.

After the rounds of intensive discussion and revisiting the interview materials, we finally reached the consensus of (RQ1) four key factors in digital teachers that impact students' experiences as (I) *voice and verbal expression*, (II) *non-verbal cues*, (III) *appearance and character choice*, and (IV) *variety and novelty*; and (RQ2) four themes on the suggested improvement and future direction for

[2] https://miro.com/.

digital teachers as (I) *situation-aware interactivity*, (II) *naturalness to human perception*, (III) *augmenting the digital teacher with more functions*, and (IV) *meaningful connection with the study subject*. Overall, we prioritized the authenticity of the findings. That said, our analysis comports with the collected data. In the next section and its subsections, we will expound upon these themes that we have identified.

3.6 Positionality Statement

Our research team, comprising postgraduate researchers, a faculty member from East Asia, and a postdoctoral scholar from the Middle East, recognizes the importance of addressing potential biases to ensure fairness in this study. Our shared cultural background with the majority of participants ($N = 26$) provides valuable insights into the local context influencing students' perceptions of digital teachers. However, this proximity may also introduce unintended biases in framing research questions and interpreting data.

To mitigate these risks, we adopted a systematic approach emphasizing objectivity and transparency through iterative processes, including regular peer reviews and collaborative data analysis.

4 Findings

This section describes the details of our participants' recruitment process, class and study arrangement, data collection, and analysis.

4.1 RQ1: How Does the Variation of Key Factors in Digital Teachers Impact Students' Experiences?

RQ1 investigates the main elements of digital teachers that influence students' learning experiences. The following subsections will elaborate on how these factors in digital teachers can impact students' learning experiences.

Appearance and Character Choice. The appearance of digital teachers created a crucial first visual impression, shaping students' overall perception of the learning experience. Student feedback can be categorized into three main areas. First, the selection of characters for digital teachers influenced their perceived credibility. Second, the rendering style played a critical role; and third, attributes such as gender, age, and ethnicity also impacted students' acceptance of the digital teacher.

Students' perceptions of digital teachers were significantly influenced by digital teachers' appearances and the chosen personas that represent them. Initial recognition and impression of the chosen characters impacted the credibility assigned to the teachers. If the characters were the digital versions of real-world figures or authorities previously known, it considerably enhanced its perceived

credibility. For instance, P6 praised the digital version of Einstein, stating, "*Being a science major at the postgraduate level, I feel the class gains more substance when Einstein teaches.*"

Regarding how the rendering styles of digital teachers influenced the student's learning experience, students had their own preference of whether they subjectively liked or disliked either style. But when judging the two styles from a more objective perspective, it could be summarized as that they prefer realistic style for real-human like characters, and photo-realistic/cartoonish style for comic characters. Both P3 and P5 emphasized how important the realistic imagery is.

Furthermore, attributes, such as gender, age, and ethnicity, did affect some students' learning experiences with digital teachers, while others did not consider these factors significant. Some students found the similarities the characters shared with them to be important. For example, student P7, a female student, remarked on her attitude towards digital teacher Fiona: "*She was also an Asian woman, which felt familiar and approachable*". Meanwhile, other students' reasons were based on their perception of the attributes of a typical post-graduate teacher. Student P15 believed that alignment with the typical image of a senior professor increased credibility, commenting, "*While I think credibility is the most important, I always believe a mature woman professor is the best option*". He also noted, "*Because of my [cultural] background, I prefer female. People at my age and from my time think women are more gentle and tender*".

Non-verbal Cues. Most students valued the non-verbal cues of digital teachers when assessing their learning experience. These cues included body movements and specific body language, such as postures and gestures. Students based their evaluations on the overall movements of digital teachers. One student (P9) noted, "*I think having body language is good. Some [digital teachers] only have stiff facial movements and single expressions, which are not very engaging.*" This shows that body language is important for making teachers seem more human-like, helping students feel more engaged and focused.

Students also mentioned how the qualities of digital teachers' movements affected their learning experience. Naturalness and smoothness were highlighted as essential. Student P9 said, "I do not like those digital teachers with too stiff movements," and "Eleanor's movements are very fake." Student P8 agreed, stating, "*I chose/[ranked] Gabriella second because her movements are smooth.*" Students P7 and P5 emphasized that natural movements help maintain focus on the content, with P7 saying, "*Unnatural movements make me focus on them [the digital teachers] rather than the course content*" and P5 adding, "*My focus is more on whether their lip movements are natural, which affects my attention to the content.*" These reflections suggest that natural movements help students concentrate on learning materials.

Regarding body postures and gestures, students preferred more variation. Student P4 criticized repetitive gestures, saying, "*Some gestures were too fixed, making the content less engaging.*" Positive feedback was given to digital teach-

ers who had varied gestures, with P8 stating, "*I chose/[rank] Gabriella second because her facial expressions and micro-movements are not repetitive, which is good.*" Student P15 explained, "*A repeated gesture pattern actually distracts me from the course and content.*" This indicates that repetitive gestures can make digital teachers seem unnatural, distracting students. Lastly, gestures that match verbal delivery were seen as a bonus, as P1 remarked, "*The main thing is when a digital teacher added gestures, their gestures moved with their tone, which I found very novel and memorable.*"

Voice and Verbal Expression. The voice and verbal expression conveyed the course content. Only a few students (N = 2) felt that voice and verbal expressions were unimportant to their learning experience. Most students shared different opinions on how these aspects influenced their understanding of the class materials. For instance, student P2 noted, "*In a slightly serious teaching environment, we usually think a more mature voice is more convincing. But many people chose the sweeter voice, possibly because it feels more relatable and friendly.*" Student P15 also preferred a more mature voice. Regardless of personal preferences for pitch and tone, students agreed that the voice should sound natural so they could focus better on the content without being distracted by awkwardness.

While preferences for pitch and tone varied, students consistently felt that accents were normal and made digital teachers seem more authentic. P13 stated, "*To be honest, an accent is something we (non-native speakers) all have ... or having an accent makes me feel like this is a human.*" This view also applied to the fluency of verbal cues. Students appreciated digital teachers who didn't speak with perfect fluency. Student P15 commented, "*A too fluent English makes me realize it is a fake character.*"

Students' feedback indicated that speaking pace and speed were important for understanding course materials. Students agreed it affected their understanding. For those concerned about their English skills, slower speech was more listener-friendly. Student P6 said, "*Speed does affect me. Slower speech is better, maybe because my English isn't very good,*" while P9 added, "*The speed affects my understanding. Slower is sometimes better.*" Student P3 emphasized the importance of clarity, stating, "*The main thing is clarity. If the speech is too fast, I might miss something.*"

Variety and Novelty. On average, students appreciated the various formats of digital teachers' presentations, which included video and VR. Except for two sessions in VR, the rest were in video format. Students highlighted aspects that influenced their learning experiences with these formats. They suggested that lectures would be improved with visual aids, like motion graphics and videos, which not only clarified the content but also sparked students' interest. This is reflected in the comments from students P4 and P15: "*Digital teachers can help in the classroom because some videos were well-edited, combining images and dynamic explanations, making long classes less tiring*" (P4); "*The video*

interaction and content with the avatar imagery make the learning interesting" (P15).

Additionally, VR presentations could enhance student engagement due to their immersive nature. Student P11 noted, "*VR has advantages. The environment is more immersive, which helps engage my learning interest, especially with traditional, scripted content.*" VR also allowed students to take control of their learning experience. P11 shared, "*In one class, we self-studied with VR, exploring independently, which improved self-learning and focus.*"

The ability to move, the rendering, and the functionality of VR presentations provided students with experiences they typically don't have in physical classrooms. Students P6 and P1 appreciated being able to adjust their distance from the slides in the virtual classroom. Student P6 remarked, "*3D might be more helpful. The PPT in VR is very large, which we can't usually see in such detail during regular classes.*" Similarly, P1 stated, "*In VR, the environment setup, with blue skies and white clouds, allows me to stand by the classroom window and look at the clouds. I felt that the environment had a significant impact on my learning, so if VR could provide this kind of pleasant environment, it would be beneficial for my studies.*" They also liked the adjustable seating, with P1 saying, "*In VR, I usually look at the notes closely.*" The VR environment positively influenced students' learning by creating a conducive atmosphere.

However, VR has its limitations, such as potential motion sickness. Student P15 mentioned, "*VR teaching is mentally demanding for me. I mean... personally, I can only stay there for 10 min concentrating...*" This suggests that it may be necessary to limit the length of VR sessions to avoid discomfort for students.

4.2 RQ2: According to Students, What are the Potential Areas for Improvement in the Implementation of Digital Teachers, and How do they View the Future of Digital Teachers in Education?

The succeeding parts describe how the digital teachers can be potentially improved according to the students. We will discuss deeper the four defined themes of improvements in the following sections.

Situation-Aware Interactivity. Most participants felt that "situation-aware interactivity" needed significant improvement, noting that current digital teachers in video and VR formats are not responsive. P8 summarized his experience, saying, "*having interactivity [in digital teachers] would be a significant improvement, enabling personalized education that can answer individuals' questions.*" He explained that AI should interact with students and answer questions, stating, "*with interaction, all other issues (like styles and design) can be resolved easily. Interaction is the most influential factor in communication.*" Similarly, P6 expressed, "*currently, it (the digital teacher's lesson) is just a one-way communication... she speaks in the video and we listen to her*," emphasizing the need for interactive teachers. He also mentioned his experience with AI Chatbots, saying,

"*I believe integrating [ChatGPT] for answering questions can increase interactivity and facilitate our learning process. I can memorize easier.*" He concluded that "*different GPT models could be trained for each specific subject.*"

P1 expressed her desire for interactive digital teachers by comparing traditional teaching with active learning, saying, "*I am actually looking for more interactions rather than just reading PPTs (slides) like many instructors did.*" She added, "*[Sometimes] it (the digital teacher) can ask questions, and [sometimes] I can ask questions. This is not a mono way but bidirectional communication. In actual class, we all ask and answer questions, right?*"

Some participants suggested additional types of interaction based on context. P12 proposed using recognizable celebrities, stating, "*I expect more interactive content. For example, bringing historical figures or artifacts into the 3D space and letting them talk to me across several lifespans would enhance classroom engagement.*" He defined interactivity as "*the method of delivering knowledge that will evolve with technology,*" emphasizing that "*content remains crucial all the time.*" P10 noted that static rules to improve interactivity are as important as responsive ones, saying, "*in Einstein's class, I remember I could walk around him, but he didn't interact with me... more interaction, like turning to face me when I move, would be better.*" P7 highlighted the importance of memory in interaction, saying, "*if digital teachers can remember me and everyone in the class, it would enhance the [learning] experience and reduce our anxiety about participation.*" However, she acknowledged the challenges, noting, "*this is so hard and insecure to do so though... as we need cameras and data storing our private information to achieve this.*"

A few participants with technical backgrounds recognized the challenges of creating interactive digital teachers. P15, a PhD student with over 20 years of IT experience, expressed doubt, saying,"*getting interaction is definitely better but as a technician, I know it's hard... It's actually impossible, right?*" P12, thinking from a developer's perspective, suggested integrating large language models into the application, stating, "*especially with advanced agents like ChatGPT, they can provide continuous interaction and support.*"

Naturalness to Human Perception. Naturalness was a common theme in participants' feedback. Most viewed naturalness as the standard for digital human applications, supporting our findings for RQ1. P2 often mentioned'natural,' saying, "*when I look at teachers, I consider many factors, not just teaching effectiveness, but also how natural the performance is.*" She added, "*naturalness is more than the term itself - I am looking for a digital teacher with realistic verbal and non-verbal features...*" P15 also emphasized naturalness as a key design guideline, noting that it should match cultural and educational backgrounds. Growing up in a non-English speaking environment, he stated, "*a too fluent English makes me realize that it is a fake character. No one can speak without stammer and mistake.*" He defined natural teaching as including speech errors. Several participants (P8, P12, P13, P15) linked naturalness to key factors identified in RQ1. P15 compared the naturalness of real and digital teachers,

saying, "*interestingly, human teachers also have constant fidgeting, but it doesn't affect me much. With digital teachers, I tend to notice gesture patterns, even if random actions are added.*"

An interesting finding was that naturalness includes more than just "human likeness" and "credibility." P7 connected naturalness to teaching quality, stating, "*the more natural they (digital teachers) seem, the higher the [teaching] quality, making it easier to accept the content and more trustworthy. As we encounter new teachers weekly, our quality threshold increases, and we are always looking for more natural teachers.*" A few participants (P7, P9, P15) noted that naturalness boosts the credibility and realism of digital teachers, suggesting they should be designed for educational contexts. Therefore, enhancing realism and credibility should be key design guidelines. P9 noted, "*I may prefer more formal settings, especially for education. I personally like formal attire in outlook and behavior.*" P7 added, "*if this is a linchpin course teaching core useful knowledge, I think credibility is needed to ensure students believe in him/her.*"

Regarding credibility, several participants stressed the importance of naturalness based on course objectives and teacher design styles. They mentioned that stylized teachers may require exaggeration, while humanoid or realistic teachers should resemble real people. P12, a fan of AIGC, emphasized, "*different teachers for different scenarios are better. For example, a two-dimensional teacher for two-dimensional content is more appropriate.*" He defined "*two-dimensional content*" as "*art or ACGN-related study subjects such as animation.*" Furthermore, most participants (N = 9) noted that being "professional" and "formal" enhances credibility as educators.

Augmenting the Digital Teachers with More Functions. Integrating multimedia and multi-modal elements was suggested to enhance the learning experience. Most participants agreed on the need for more interaction and diverse presentations from digital teachers. P9 proposed creative multi-modal features, stating, "*I am looking for more functions, like Liu Qiangdong's sales. Referencing such formats to demonstrate in-class experiments is awesome.*" He also suggested, "*I expect not just videos but also demonstrations, white-boarding, and experiments!*" P14 highlighted "*storytelling and gamification elements*" as innovative approaches but cautioned that content must relate to the class, noting, "*the story of Aria is great but a bit off-track.*"

Empowering students to engage in various tasks beyond traditional learning can foster ownership. P1 recalled her experience with online platforms, saying, "*personalized learning where they skip parts I already know would be great.*" P6 noted, "*digital teachers can democratize education by allowing experienced teachers to share their knowledge widely.*" P15 mentioned revisiting digital teachers for his customized learning path.

Accessibility is also crucial. Expanding asynchronous and large-scale learning can enhance the process. P15 emphasized improving digital teachers' accessibility across platforms, stating, "*The ideal part would be how the virtual teacher can assist my learning 24/7, like J.A.R.V.I.S. in Iron Man. This is the most*

beneficial part compared to human instructors." P1 agreed on the importance of accessibility, saying, "*I hope I can attend classes from home with a headset, regardless of location, which would be a big improvement.*"

Meaningful Connection with the Study Subject. The theme of customized digital teachers was mentioned nine times by interviewees, who agreed that such teachers can enhance learning efficiency. They emphasized that these digital teachers should connect meaningfully with the subject matter. P15 noted, "*Conceptual content is more suitable for digital teachers since it is scripted and organized.*" He added that for subjects like mental health, "*it is probably fine to have anime or cartoon agents, as digital Ben [the digital version of real instructor] cannot help you relax.*"

P7 suggested that digital teachers could be useful for conceptual courses, stating, "*They can't fully replace real teachers but can handle some parts of the lessons. A mix of digital and real teachers would be ideal.*" P4, considering course design, said, "*different teachers in different scenarios may be better. For example, a two-dimensional teacher may give 'two-dimensional' explanations, like using anime for related subjects.*" She explained that "*the Einstein we had in class is a cartoon anime character, and when you have such a digital teacher, won't you feel he is teaching a physics class?*" P10 discussed VR digital teachers, clarified that "unassuming" subjects refer to scripted content.

While not frequently mentioned (verbally), most participants linked digital teachers' design to course content. Five major types emerged from the design worksheets: (i) fictional stylized (N = 2), (ii) fictional realistic/humanoid (N = 4), (iii) stylized with reference (N = 4), (iv) realistic/humanoid with reference/historical figure (N = 3), and (v) non-human (N = 2). For example, P6 designed Chongzhi Zu, a historical figure, to teach mathematics, aligning with cultural background. P4 referenced *Rick and Morty* to teach the Multiverse concept, aligning with course goals. Most design worksheets (N = 13) showed a connection between digital teachers' design and course content, highlighting that meaningful connections with the subject are crucial design guidelines.

5 Discussion

5.1 Digital Teacher as a Complementary Role

Substituted. This research suggests that digital teachers and human instructors cannot fully replace each other due to their different formats, practices, and roles in the classroom. Instead, AI lecturers support human teachers. Unlike traditional lecturing, where professors explain course content, AI lecturers can enhance student engagement by integrating various media into presentations.

Personalized. Digital teachers should resemble real people in character and attitude to feel more relatable. Realistic or photorealistic styles make digital teachers appear more natural, while 3D stylized or comic styles may seem awkward and lead to the uncanny valley effect. Regardless of the style, authentic

movements and expressions are vital for keeping students focused and interested. A balance between familiar and unfamiliar character traits can enhance the subjective teaching experience.

5.2 Enhanced Learning Experience and Engagement

Media Integration. Our research emphasizes the importance of media integration in digital teaching. AI lecturers can present real events through videos, sound effects, and historical narratives, enhancing students' immersion in the classroom. They can create unique experiences, such as storytelling sessions, where students can "experience" textbook knowledge.

Diversified Choice of Contents and Practices. Currently, AI lecturers cannot interact with students directly, as content accuracy must be ensured through manual review by teaching teams. Digital teachers and human lecturers serve different roles; AI focuses on elaborating existing knowledge rather than introducing new concepts. Human instructors excel at explaining complex theories, using personal examples and real-time discussions. Introducing new characters in each class keeps students engaged and excited for lessons. Characters in VR teaching formats boost enthusiasm and allow students the freedom to learn independently.

5.3 Accessibility and Equity: Asynchronous and Personalized Education

AI instructors enable flipped classrooms and asynchronous learning. Students learn outside of class through pre-recorded lectures, readings, or online resources. Class time is then used for interactive activities, discussions, and problem-solving, promoting active learning and allowing students to seek help from instructors as needed. This approach increases accessibility, inclusivity, and flexibility, enabling students with different needs and understanding levels to progress at their own pace. Additionally, AI teachers can also reach many students at once in form of **massive open online course or blended learning**, helping to address teacher shortages, especially in underdeveloped areas.

5.4 Teachers For All: Design Considerations

Ninety percent of our interviewees ($N = 20$) expressed enthusiasm for having digital teachers and engaging with them in various activities. Concerns arise about whether human teachers will be too idle while AI lecturers lead discussions. Human teachers should actively assist in the classroom. Greater engagement is needed, such as VR storytelling by digital teachers and collaborative learning activities. Teachers can adapt their methods and incorporate new information to ensure students receive up-to-date educational content and use examples to clarify details.

5.5 Limitations and Future Work

This study provides valuable insights into the impact of digital teachers on students' learning experiences but has limitations. First, the reliance on interviews may introduce biases due to self-reporting. Future research could use a mixed-methods approach, incorporating quantitative data like performance metrics for a fuller understanding. Second, the small sample size limits the generalizability of the findings. A larger, more diverse sample would yield stronger conclusions about different demographic groups' interactions with digital teachers. Additionally, the current design of digital teachers lacks interactivity and responsiveness, limiting their effectiveness. Improvements in these areas are essential.

Future research should focus on creating personalized, interactive, and responsive digital teachers, such as avatars that adapt to individual learning styles and provide tailored feedback.

Interactivity is crucial; digital teachers should enable bidirectional interactions, including real-time Q&A sessions and adaptive learning paths.

Enhancing accessibility is also important. Future digital teachers should use multiple communication channels, including social media, to allow more ways for students to interact.

Integrating digital teachers into platforms like Massive Open Online Courses (MOOCs) could expand their reach and impact, providing high-quality education to a broader audience and addressing educational inequities.

In conclusion, while this study highlights key aspects of digital teachers, there is significant room for improvement. By addressing limitations and focusing on enhancements, we can work towards the vision of "Teachers for All," ensuring a more inclusive and effective educational experience for all learners.

6 Conclusion

"Teachers for All" envisions a future where technology enhances education, addressing the shortage of trained teachers and inadequate materials while improving personalized learning. This paper examines how different aspects of digital teachers affect students' experiences and identifies areas for improvement.

Our findings show that verbal and non-verbal cues significantly shape learning experiences. Clear, natural-sounding voices are preferred, while facial expressions and body language are crucial for engagement and credibility. Characters resembling real people, like digital versions of professors or Einstein, boost trust and engagement. However, unrealistic or overly stylized characters can trigger the uncanny valley effect, highlighting the need for authenticity. The design of digital teachers should align with the subject matter; playful characters like anime should be used for general education or mental health courses, while realistic characters should be employed for more serious subjects.

Introducing new characters and storytelling methods can increase student enthusiasm. VR teaching formats, especially with familiar figures, create immersive learning experiences, but repetitive gestures and difficulty revisiting classes need improvement.

Future research should prioritize interactivity and personalization. Students want bidirectional interaction for a more engaging learning environment. Personalized digital teachers that adapt to individual learning styles could greatly enhance educational outcomes.

Digital teachers can also support traditional teaching by taking on certain roles, reducing the workload for human educators. Integrating digital teachers with VR and MR technologies can create a more immersive and interactive learning environment.

Accessibility and equity are crucial. Digital teachers can democratize education, making it available to a wider audience. Using various social media platforms can further improve their accessibility and effectiveness.

In conclusion, the future of education depends on effectively integrating AI and Metaverse technologies. By addressing current limitations and embracing innovation, we can move towards the vision of "Teachers for All," ensuring every learner has access to the resources and support they need for a more inclusive and engaging educational experience.

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