Augmented Reality as a Pedagogical Tool in Cultural Education: A Case Study on Srimulat-Based Cultural Learning Among University Students (copyediting)

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ABSTRACT (9 pt)

Objective: *This study explores the potential of Augmented Reality (AR) can be used as a learning tool to help college students learn more about Srimulat, a traditional Indonesian comedy troupe that younger generations are losing interest in. As students who grew up with digital media become less interested in local performing arts, it becomes more important to include heritage content in interactive media. To fix this, an AR app was made using user-centered design principles, which focus on the needs and habits of students, and multimedia learning theory, which says that using pictures and narration together can help people understand better. The app used 3D models, voice narration, and interactive posters to show Srimulat characters. The program was used in a university exhibition and involved 68 students who took pre-test and post-test to see how much they had learned. The results showed a big increase in knowledge, with post-test scores going up by an average of 24.1 points. Additionally, 94% of participants reported enjoyment, while 91% claimed to have a better understanding of the cultural aspect. Although these statistics are positive, the study took place at a single school, and it only examined short term learning effects. Future research, in order to further support of its role in cultural education, should examine long-term learning effects, cross-cultural comparisons, and methods for integrating AR, in formal educational contexts.*

INTRODUCTION

One of the significant groups of Indonesian entertainment history in the comedy performance area, Srimulat has a past dating back to the 1950s when Teguh Slamet Rahardjo and R.A. Sri Mulat formed the group. Srimulat typified a style of theater that involved a historical Javanese performance with a populist (rakyat) humorous approach to social satire (Weintraub, 2021). By this point, Srimulat was already using a mixture of famous characters, such as Gepeng, Asmuni, Timbul, and Nunung, to entertain patrons who were old and young, of all races, and from all classes (Lesmana & Hariyanto, 2021).

Srimulat's presence has faded significantly among younger generations in this era of rapid digital change. Gen Z, often referred to as digital natives, are young people living in environments characterized by loads of visuals and fast content like TikTok, Instagram, and YouTube. These types of media focus on short-form content, instant gratification, and algorithmic personalization features that are very different from the slower, dialogue-rich stories that are common in traditional stage performances (Alzubi, 2023). Statistics Indonesia's data shows that fewer young people are participating in and aware of local performing arts. This suggests that they are becoming less interested in classical cultural icons (Ramadani et al., 2022). This lack of connection is a significant danger to the long-term health of cultures and the passing down of knowledge from one generation to the next.

While those digital natives are more open to immersive and interactive technologies, augmented reality (AR) is recognized as an education tool, stimulating cognitive engagement, emotional immersion, and learning in context (Spadoni et al., 2022). AR allows for a specific type of learning where the real world is enhanced by digital information. Thus, it engages the senses of the participant with cultural content and events. Cheng (2023) lists interactivity as an attribute of AR that socially engages people

and culturally empowers them through the retelling of heritage objects. AR has been shown to be helpful in both museums and classrooms for getting people interested and helping them remember what they learn (Farianto et al., 2021).

This growing gap between generations reveals a paradox in how people engage with culture today. While traditional performance arts struggle to stay relevant, younger people are increasingly drawn to experiences that incorporate technology. Young people who grew up with technology, often called "visual learners" or "screen-oriented audiences," are very responsive to media formats that allow for interactivity, personalization, and immediacy (David, 2022). This generation does not want to reject culture completely; instead, they want to engage with it through platforms and interfaces that fit with how they consume media (Alzubi, 2023). So, the task is not only to bring back old content but also to put it in the digital languages that young people use today. Zaidi et al. (2024) emphasize the role of culturally adaptive digital media in bridging generational divides, arguing for the integration of traditional narratives into immersive digital forms such as AR to create emotionally resonant and socially meaningful experiences.

According to McGinty (2021), the present project was initiated to develop and use an AR-based instructional material that brings alive the personalities, aesthetics, and historical significance of Srimulat in an appealing manner. The study aimed at evaluating the effectiveness of technological media, specifically AR, in enhancing students' understanding of local cultural heritage. This project is focused on reviving Srimulat, which had once been a popular Indonesian comedic troupe but is now almost forgotten, so that this can once again be made known to the digital generation. The specific objectives of this research would be to (1) develop and implement AR-based learning media grounded in established learning theories, (2) measure its effect on students' understanding and appreciation of local cultural heritage, and (3) propose a delivery model that may be utilized for the purpose of developing immersive learning environments. This project aims to develop and evaluate technology-based learning materials, especially AR, in reviving the characters, aesthetics, and historical values of Srimulat for students, that is, the younger generation. AR serves here as a teaching technology to communicate in a relaxed yet engaging manner (McGinty, 2021). This activity encompasses several stakeholders, with an emphasis on organizing an interactive exhibition that fuses authentic artifacts of the Gubuk Wayang community with mobile AR technology accessed via students' devices. It thus provides a contextual learning situation, aligned with the media consumption practices of the contemporary generation (Jasmineet al., 2025).

What makes this project unique is the implementation of a model that integrates physical cultural artifacts with AR interactive experiences relevant to a real higher education context. The above application also distinguishes itself from most previous innovative culture-and-technology-based projects that stood on no strong pedagogical underpinning whatsoever. It foregrounds the use of a user-centered design (UCD) approach to make sure the media responds to students' interaction patterns with digital technologies and the application of multimedia learning theory (MLT) principles to allow simultaneous information processing through two channels so as to enhance memory retention (Sanfilippo et al., 2022). The exhibition was conducted jointly by Gubuk Wayang cultural organization and Monster AR as a developmental technology that affords students the experience of multimedia learning through direct observation of

artifacts, 3D modeling of artifacts, explanations within the application, and visual markers, which are all intended to engage students directly as users and make possible the coding of cognitive memories of the knowledge shared.

The study uses both quantitative (pre-post testing) and qualitative (observational) methods to give us not only measurable results but also insights into the emotional and behavioral aspects of immersive cultural learning (Kaczynski et al., 2024). Finally, this study suggests a scalable and theoretically sound way to use AR in cultural education. This is an important gap in the current literature, where heritage preservation, educational technology, and user experience design rarely come together in a single framework.

RESEARCH METHOD

This study employed a design-based research approach with a focus on community involvement, aiming to develop and evaluate an augmented reality (AR) application for cultural education, especially engaging the digital-native learners interested in exploring their local culture. The program was conducted within the bounds of the Universitas Ciputra Surabaya with undergraduate students, given that they are very much into technology, greatly relate to learning innovation, and can have the ability to be cultural intermediaries (Bakhov et al., 2024). The AR Srimulat application was designed under the user-centered design (UCD) paradigm. The UCD approach emphasizes the application of user needs, desires, and actions in the design process (Nguyen Ngoc et al., 2022). AR Srimulat was developed following User-Centered Design (UCD) principles and considering the user's wants and preferences to the greatest extent. Preliminary user research was carried out to understand student behavior on the internet and their acquaintance with local cultural content. UI and UX were designed to provide a friendly and easy experience on mobile Android devices (Zhang & Liu, 2022). The outputs were made using marker-based AR applications for Android. Assets were scanned with Luma AI, and LiDAR mapping was employed to create an immersive experience (Lee et al., 2021).

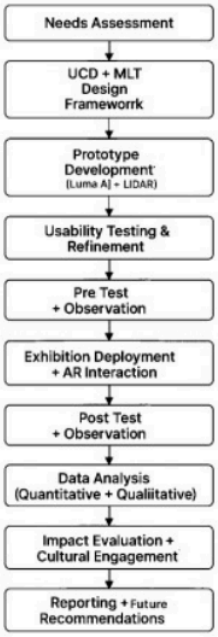

Figure 1. Research Flow Diagram.

Research Design

The study was conducted in three phases:

1. Design and development of the AR Srimulat application.
2. Implementation by putting it into use in an interactive exhibition.
3. Evaluation of educational impact using a mixed-methods approach on the effectiveness of the application as a teaching tool.

The UCD approach was employed to ascertain worth and relevance during product development. UCD puts emphasis on timely feedback, user testing, and active user participation in the design process (Nguyen Ngoc et al., 2022). It reveals to the application how students interact with technology, their preferences, and what they need. The educational content of the application was, in fact, designed following Multimedia Learning Theory (MLT). It posits that processing information both visually and verbally creates pathways into the memory, thus improving understanding and retention (Mayer, 2024). An application has been designed that uses both synchronized 3D graphic imagery and short text descriptions to depict each Srimulat character. Not only to maintain the interest of the user but also to avoid cognitive overload, cut up and time these audio-visual multimedia components (Opara et al., 2025). To ensure that the results of the study were fair, the researchers involved used the same group in both pre- and post-tests and hence were able to determine the impact of AR media on learning. This method permits comparison between groups as it measures their improvement (Lee et al., 2021). Paired samples and a question were utilized to strengthen the analysis to examine any statistically significant score differences. This inferential method, alongside the

descriptive statistics, has shown that the intervention worked and thus allayed the fears of causal inference and internal validity.

Research Participants

A number of 68 students from various study programs became stakeholders of the project. Before the intervention, participants were screened to establish that they probably had not been exposed to Srimulat in the recent past. This fact was paramount for ensuring a correct assessment of the amount of knowledge gained. Their various academic backgrounds generally matched their digital learning profiles and would therefore be appropriate to test AR's effectiveness on cultural learning. The fact that participants chose to take part in the intervention made it much more engaging. People chose to join the program because they were genuinely interested in learning about new technologies that could be applied to the study. Most of the people who took part were in their second or third year of college. This shows that they were academically mature but still in the process of developing their cultural identity (Mitchell et al., 2021).

The group was made up of people who were like digital-native learners, or students whose learning behaviors and expectations are shaped by being around digital technology all the time. Students naturally prefer learning environments that are interactive and mobile-friendly (David, 2022). These people were very good at using mobile apps. They said they would rather use multimodal instructional materials, which is in line with recent research by Rahardi (2024), which stresses how important it is to match instructional media with students' digital skills. This made them very good at testing an educational tool that used AR. Their digital skills also helped them participate in the user testing and implementation stages in a way that was useful and consistent, giving feedback that was useful and consistent. The participants' ability to think critically about their interactive experiences (Teasley et al., 2021) made the post-intervention findings more meaningful, especially in terms of usability, emotional engagement, and perceived learning effectiveness. So, their involvement not only made the evaluation process more reliable, but it also showed that AR is a good way to teach cultural literacy in college.

Development and Implementation

Using Luma AI to scan cultural artifacts related to Srimulat and LiDAR technology to create spatial maps (Sato & Yaguchi, 2024). There were visual markers on the exhibition poster to trigger the appearance of interactive 3D models showing signature gestures and traits of famous Srimulat characters like Gepeng, Asmuni, and Timbul. In development, the app was set out as per Multimedia Learning Theory so that it would be easy to learn from. This framework recognizes dual-channel processing of visual and verbal input to enhance memory and cognitive processing (Vu et al., 2022). In the app, each character was rendered with 3D models, audio storytelling clips, and text descriptions (He & Wu, 2023). These assets were designed, at least partly, to help users avoid cognitive overload by breaking up the information and allowing users to go at their own pace. With Luma AI, high-quality 3D scans of cultural artifacts relating to Srimulat were accomplished (Sato & Yaguchi, 2024), and with LiDAR scanning, the physical exhibition space was mapped (Yang et al., 2025). Printed posters around the exhibition served as entry points

for the AR content via marker-based AR technology. Through this arrangement, people could engage with the digital avatars of Srimulat's celebrated character actors in a lifelike manner by scanning visual triggers with their mobile phones.

68 students participated in the pre-test and post-test process through a closed-ended questionnaire consisting of 10 statements assessing their knowledge of Srimulat's cultural significance before and after interacting with the AR media. Usability data from the survey was collected, and observers monitored how users interacted through close observation and digital footage and also documented all ad-lib comments. In the end, a descriptive quantitative design was used. It compared the scores of the pre-test and post-test to see how much knowledge had been gained (Fischer et al., 2023). This measure of knowledge acquisition was supported by observational evidence that identified qualitative indicators of learning, including curiosity, excitement, and depth of interaction. The use of mixed methods adds to the richness and thoroughness of evaluating the educational impact of the AR media. The combination of quantitative and qualitative methods also lends more support to the proposition that AR can be a meaningful and fun way to deliver learning about culture (Mulisa, 2022).

Instruments and Data Collection

A closed-ended questionnaire and structured observation field notes were used to evaluate the application of AR Srimulat in students' cultural learning. The questionnaire will consist of ten questions designed to assess students' knowledge and utility, emotional engagement, interest in local heritage, and perceived value of culture. Using a 5-point Likert scale from 1 = strongly disagree to 5 = strongly agree allowed standardized quantitative analysis of all subjects (Fischer et al., 2023). The assessment was administered to the subjects at two points in time before the exhibition (pre-test) to ascertain the level of culture knowledge and attitudes, and immediately after AR interaction (post-test). This design enabled the analysis of knowledge and attitude shifts that occurred as a result of the intervention.

Table 1. Test Evaluation of Srimulat Augmented Reality Media

No.	Statement	Pre	Post
1.	I am familiar with Srimulat	√	√
2.	I can recognize the characters from Srimulat.	√	√
3.	I have used Augmented Reality and had an engaging learning experience	√	√
4.	Name one character from Srimulat that you know....	√	√
5.	Srimulat characters have uniqueness in terms of...	√	√
6.	The Srimulat character shown through AR represents the type of wayang?	√	√
7.	The information presented about Srimulat is clear.		√
8.	It is easy to recognize Srimulat characters using Augmented Reality.		√
9.	The learning process feels more engaging using Augmented Reality.		√
10.	Name one Srimulat character you saw in the AR media.		√
11.	After using Srimulat AR, I feel that my knowledge about Srimulat has increased.		√

Besides the survey data, qualitative data were collected by structured observation. During the exhibition, trained research assistants noted a variety of student behaviors

with respect to interactions such as engagement time with the media, facial and verbal expressions, spontaneous comments, and instances of peer discussion. Such observations offer unobtrusive insights into how participants interacted with the media and added rich context to the questionnaire data collected. Observation notes were then thematically coded later in order to triangulate these findings and deepen their interpretative significance (Daniel et al., 2023).

RESULTS AND DISCUSSION

Results

Sixty-eight students from diverse academic backgrounds attended the Srimulat-themed augmented reality (AR) exhibition at Universitas Ciputra. Most participants reported having limited prior exposure to Srimulat, highlighting a generational gap in cultural familiarity. During the exhibition, students engaged with posters embedded with AR markers that, when scanned through a mobile application, activated 3D character models, voice narration, and short animations designed to convey Srimulat's cultural attributes.

Pre-Test and Post-Test Comparison

To evaluate changes in cultural awareness and character recognition, a closed-ended questionnaire with 10 Likert-scale items was administered before and after the exhibition. The following table summarizes the score improvements across two key indicators:

Table 2. Comparison of Pre-test and Post-test Scores

Indicator	Pre-test	Post-test
Awareness of Srimulat	2.3	4.4
Recognition of Srimulat characters	2.8	4.6

Notably, 85% of participants were able to name at least three Srimulat characters after the exhibition, compared to only 22% before the intervention.

User Perception and Engagement

Post-test survey responses demonstrated a strong positive reception toward the AR experience:

- Enjoyability: 94% of students agreed or strongly agreed that the activity was enjoyable.
- Content Comprehension: 91% indicated that the combination of narration and visuals improved their understanding of Srimulat characters.
- Usability: 79% rated the mobile application as intuitive and easy to use.

- Cultural Insight: 86% reported increased knowledge about the history and values of Indonesian comedic heritage.

Observational Insights

Structured observations during the event yielded the following qualitative findings:

- On average, students spent 3 to 5 minutes engaging with each AR character station.
- Several groups engaged in spontaneous peer discussions, particularly when identifying characters or recalling familiar traits.
- Emotional engagement was evident, with students expressing laughter, curiosity, and nostalgic recognition.
- Some participants shared personal memories of watching Srimulat with family members, suggesting that the AR content triggered intergenerational cultural associations.

These results reflect both quantitative and qualitative dimensions of engagement, highlighting the impact of AR media in facilitating cultural recall and participatory learning among digital-native students.

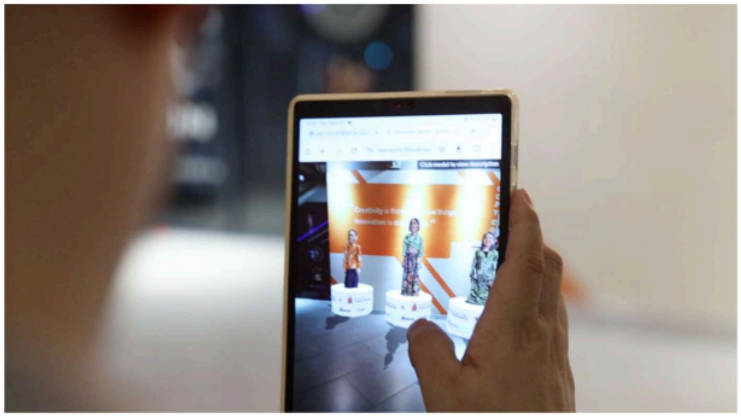

Figure 2. Documentation of Student Interaction with the AR Srimulat Media

Discussion

The Srimulat-themed Augmented Reality (AR) exhibition attracted 68 university students from various study programs, most of whom reported limited prior exposure to Srimulat. This was reflected in the low average pre-test scores: 2.3 for awareness and 2.8 for character recognition. After experiencing the AR application, which combined 3D models, voice narration, and animated vignettes, students showed marked improvement: post-test scores increased to 4.4 and 4.6, respectively. These results demonstrate the effectiveness of the AR intervention in enhancing both cognitive recognition and affective engagement with local cultural material. This study, combined with findings from others

who placed AR as a method for bridging technological and generational gaps in heritage education (Zwegers, 2022), demonstrates AR's power as a delivery tool and a transformative agent in recontextualizing cultural engagement, which can help increase student curiosity while developing their cultural appreciation.

These findings strongly support MLT (Multimedia Learning Theory). MLT argues productive learning results when students take in both verbal and visual information at the same time (Makransky & Mayer, 2022; Mayer, 2024). In this study, all three elements of both narrative audio, visual models, and text explanation had the potential to facilitate dual-channel processes that would help learners gain knowledge and ability to retain knowledge from their experience. User-Centered Design (UCD), based on Belcher's (2021) User-Centered Design. The intention of UCD is to create user-friendly materials giving priority to accessibility, usability, and emotional pull (Teasley et al., 2021). In this study 79% of students said it was intuitive, and 94% agreed the experience was enjoyable. UCD ensured that the manner in which technology was delivered matched the respondent's own habits via digital platforms aligned with their digital, mobile-first, multimodal technological preferences and habits (David, 2022). This supports prior findings by Wen (2021) and Liu & Hongxia (2024), which argue that AR experiences that are culturally contextualized and multisensorial enhance learner curiosity, satisfaction, and recall. This study extends these insights by applying them within a non-formal, co-curricular setting a university exhibition proving that AR's pedagogical potential is not limited to structured classrooms (Arvola et al., 2021). In addition to quantitative data, qualitative observations further revealed high emotional involvement. Students expressed nostalgic connections to Srimulat, shared family anecdotes, and often laughed or verbalized recognition during the experience. A number of study participants recalled family stories and/or presentations they may have previously witnessed before Srimulat. This demonstrates how digital interventions can be a catalyst for intergenerational memories. This is in alignment with Siliute & Westberg (2023), whose research suggested that immersive technologies in a scene context can link youth to cultural narratives they may not have been directly exposed to.

Figure 3. Documentation of Student Emotional Engagement

This affective reaction shows AR's capacity for intergenerational cultural memory through participatory media products, which is supported by Siliute & Westberg (2023)

and devices Zhang & Liu (2022) as they show youth connect with heritage stories through AR. The results in this study affirm the pedagogical function for Augmented Reality (AR) as a medium of cultural education, particularly when implementing, as in this example, established frameworks such as Multimedia Learning Theory (MLT) and User-Centered Design (UCD). The implementation did also expose a few technical challenges that had to be dealt with. Some students had indicated evident lags in marker detection within the AR app, especially in less than ideal lighting or when they used smartphones that were in the mid-range of older devices, which caused them less-than seamless interactions with the app. These limitations relate to those addressed in the literature base surrounding AR usability (Liu & Hongxia, 2024), which advocates acknowledging device optimization and environmental readiness for future AR use (Al-Ansi et al., 2023). Despite the high levels of engagement and cognitive gain observed for the overall experience, this study suffers from a variety of methodological limitations. These limitations include the lack of a control group to ascertain the educational effects of AR against other media or traditional teaching practices, thereby lowering the internal validity of any causal claims. The results are also based on a short-term, immediate, post-intervention evaluation which would prevent a deeper understanding of any long-term knowledge retention or behavior change. These limitations reflect concerns in the AR evaluation literature about the need for more rigorous experimental design to legitimize pedagogical efficacy (Makransky & Mayer, 2022; Spadoni et al., 2022).

In addition, technical limitations were experienced during the implementation with the technology. For instance, some students encountered lagging AR responses that were the result of insufficient lighting in the students' learning space or lower-performing mobile devices, which impacted the reliability of marker detection and a satisfying user experience with the technology. Such issues have been stated elsewhere in previous AR usability studies (Woodward & Ruiz, 2023),and reinforce the importance of considering hardware compatibility, and preparing the environment for augmented reality experiences prior to using augmented reality in real-life educational contexts. Following the design improvisation there is important built design knowledge about technologies including adaptive placement of markers, performance calibration of lighting, and performance enhancements of mid-range devices for future additional iterations. Even with all of the challenges of working with new innovative technology, this research builds knowledge on the growing body of work that suggests AR has a very special affordance for cultural education. As compared to previous instances of AR used for museum and classroom-based heritage learning (Spadoni et al., 2022; Wen, 2021), in higher education, this study illustrates the expanded use of AR into a non-formal exhibition space at the university level, that served as an experience for students and connected them to the virtues of cultural transmission, even if spatial access was provided outside the confines of formal curriculum learning. The use of AR in a conceptual and practice-based cultural capacity beyond formal learning highlights interesting potential when extrapolated to cocurricular and informal learning spaces that seek to engage the media habits of a digital natives. In summary, this study confirms that AR, when designed through UCD principles and grounded in MLT, can effectively enhance cultural understanding, learner engagement, and emotional resonance. It not only functions as a content delivery tool but also as a medium for cultural revitalization.

The qualitative observations had supported their quantitative results by indicating emotional engagement and reflective thought in participants (Kaczynski et al., 2024). This study's findings are also consistent with other studies on cultural AR in museums and classrooms (Spadoni et al., 2022; Wen, 2021), where users expressed greater interest and showed better retention. Unlike the above, this study attempted to look into a less formal co-curricular setting (an exhibition at the university), unlike structured curricula. This shows that AR can work even outside of formal learning settings. This suggests that AR could be used in more situations as a link between heritage, entertainment, and education. The results also have implications for formal education, where AR media can be used in history, art, or cultural studies classes. AR, therefore, does not merely serve as a didactic presentation tool but becomes a catalyst for broader cultural dialogue and revival (Rane et al., 2023), especially when implemented in educational spaces where critical reflection and identity formation occur.

In short, this study shows that MLT and UCD are still important frameworks, but future research should go beyond confirming their usefulness and look into how these models can change to fit learning environments that are becoming more complicated. AR should not only improve content; it should also become a culturally embedded, student-driven learning environment that is open to everyone, endures over time, and adapts to technological limitations and the needs of different users. More research into gamified content, multi-user interaction, and long-term impact studies will also be important for utilizing AR in education to safeguard cultural heritage. Future implementations can adapt this model across different cultural domains, such as local folklore and traditional music, and highlight its significance in sustaining intangible heritage in Indonesia during the digital era.

CONCLUSION

This research demonstrates that augmented reality can serve as a useful device for teaching university students about other cultures. User-Centered Design (UCD) and Multimedia Learning Theory (MLT) underpinned the design of the AR Srimulat app which brought back the Srimulat, one of Indonesia's most famous traditional comedy troupes, to a novel cluster of students. Among key findings, a lot of growth in the students' knowledge and understanding of the cultural and historical context of Srimulat was measured by various studies including a pre- and post-test and observational data. Over 90% of the respondents of the app confirmed enhanced understanding of the Srimulat characters and social values they represent. Implications of these findings extend beyond this project. If educational media featuring augmented reality are thoughtfully designed and based on strong educational theory, they can be much more than an engaging means of content delivery. It becomes a way of passing on culture that speaks to the mind and heart. This is especially essential for digital learning environments today, where engagement, personalization, and interactivity are things that make learning fun.

The AR Srimulat model can be further modified and used for other cultures as a strategic bridge that will close the gaps in heritage education for generation and technology. There are still several weaknesses in this study. First the sample size was too small and limited to students from only one university which would likely limit its generalizability to other situations. Second, the evaluation was based mainly on users'

short-term gains in knowledge and feedback but had little focus on behavior or retention over the longer term. User experience was also marred by other technical problems, like incompatibility with devices and the setting, which made it difficult to scan markers. Further studies should focus on the implementation models in a wider variety of schools and demographic differences. Long-term studies should consider how augmented reality-based learning relates to cultural and identity formation over time. Further investigations into employing augmented reality in the context of curriculum-based instruction in schools will probably give organized ways of adopting it in schools. Moreover, they could also make the future applications very useful and easy to access and function for more users by adding items like gamification, adaptive storytelling, and comparison of cultures.

In an expanding debate about design and education concerning immersive technology, the project adds something significant. It highlights how design-thinking approaches can contribute to producing culturally rich, user-friendly, and effective learning tools. The AR Srimulat project offers a powerful example to researchers, teachers, and designers for achieving educational objectives through creative media design that promotes cultural awareness, engages students, and encourages lifelong sharing of knowledge within higher education environments.

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