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Integrating Animation and Immersive Media into Educational Storytelling: A Mixed-Method Classroom Study

Yu-Xuan Teo
teo.yuxuan@student.mmu.edu.my
Multimedia University, Malaysia
ORCID iD: 0009-0009-1216-1112
(Corresponding Author)

Jun Wei Geuan
geuan.jun.wei@student.mmu.edu.my
Multimedia University, Malaysia
ORCID iD: 0009-0000-9004-635X

Abstract

Digital storytelling, supported by animation and immersive media, is increasingly used to enhance student engagement and deepen understanding. This study examines the impact of animated narratives and virtual environments in primary school classrooms, comparing them with traditional teaching approaches. A mixed-method design was employed, involving 46 students over a six-week module. The experimental group engaged with animated lessons, virtual reality simulations, and augmented reality applications, while the control group received standard instruction. Quantitative data from pre- and post-tests showed a 17% improvement in academic performance for the experimental group, compared with an 8% increase for the control group ($p < 0.05$). Student engagement scores rose across emotional, behavioural, and cognitive domains, while qualitative feedback highlighted improved confidence, greater conceptual clarity, and sustained motivation. Findings confirm that immersive media can support active learning, promote collaboration, and make complex concepts more accessible. While the study was limited by its small sample size, short duration, and potential novelty effects, it offers practical implications for integrating cost-effective immersive tools into everyday teaching practice.

Keywords Digital storytelling; Immersive media; Animation; Virtual Reality (VR); Augmented Reality (AR)

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Introduction

Animated digital storytelling and immersive media have emerged as influential educational tools in recent years, supporting greater student engagement and deeper understanding of lesson content. Digital storytelling blends traditional narrative techniques with multimedia elements such as animation, virtual reality, and augmented reality, enabling more interactive and immersive learning experiences. For example, a study in China found that when primary school pupils learned mathematics through digital storytelling, they reported higher confidence and interest (Niemi & Niu, 2021).

Evidence suggests that this approach can also enhance academic performance. Nam (2016) reported that students engaged in digital storytelling within online learning environments achieved better results and felt more connected to their peers. Immersive storytelling, whether through virtual reality simulations or animated lessons, has been shown to improve focus and promote long-term retention. Smeda, Dakich, and Sharda (2014) found that students learned more effectively when lessons were delivered through engaging digital narratives. In practice, institutions have adopted such tools successfully: the Norman Rockwell Museum developed a virtual field trip programme enabling students to explore more than 250 artworks online, enriching the study of history and art (Kiessling, 2024).

By combining storytelling with digital technologies, educators can create engaging, interactive lessons that support comprehension of complex concepts and foster stronger connections between learners and subject matter. This approach not only stimulates curiosity but also encourages an immersive educational experience that can adapt to diverse learning needs and environments.

Literature Review

Storytelling and Its Role in Education

Storytelling has been an integral part of human culture for millennia, serving as a medium for transmitting knowledge, values, and experiences. In education, it remains a powerful tool for fostering emotional engagement and enhancing memory retention. When lessons are presented as narratives, students are more likely to relate to the material and recall it over time.

Digital Storytelling

Digital storytelling integrates traditional narrative techniques with modern multimedia formats, including animation, video, and audio, to create richer and more engaging learning experiences. Research demonstrates that incorporating digital storytelling in the classroom can significantly enhance student engagement and improve learning outcomes. By converting abstract concepts into relatable

narratives, students find the content more approachable, leading to increased enthusiasm and participation (Smeda, Dakich, & Sharda, 2016).

Multimedia Learning Theory (Mayer's Cognitive Theory)

Richard Mayer's Cognitive Theory of Multimedia Learning (2005) provides a framework for understanding why combining text, visuals, and audio can be particularly effective. The theory is underpinned by three principles:

1. Learning occurs through two channels, that is, visual and auditory.
2. Each channel has a limited processing capacity.
3. Active learning occurs when learners integrate new information into existing mental models.

When animations or narrated visuals align closely with written content, comprehension and retention improve. Conversely, excessive or poorly coordinated stimuli, such as fast transitions, loud background audio, or unrelated imagery, can lead to cognitive overload. Mayer's framework therefore emphasises the importance of coherent, focused content design. This theory has guided numerous studies and practical applications, offering a strong foundation for integrating animation and storytelling in educational contexts.

The Rise of VR, AR and Immersive Tools in Education

Virtual Reality (VR) and Augmented Reality (AR) are transforming educational practice by enabling students to move from passive observation to active participation. These technologies provide spatial and experiential learning opportunities that can make content more memorable and relatable.

For instance, the Australian startup Mindflight7 has developed VR experiences allowing students to explore historical events and ecosystems without leaving the classroom (The Guardian, 2025). Similarly, at the University of the Sunshine Coast, students collaborate with HavenXR to design immersive learning environments, gaining hands-on experience in extended reality development (Kirkland, 2024).

Research indicates that immersive media can enhance memory retention by situating learning in a simulated real-world context (Smeda, Dakich, & Sharda, 2014). Such tools are especially effective in making abstract or distant phenomena — from ancient ruins to planetary systems, tangible and accessible.

Gaps in the Current Research

Despite promising results, several gaps in the literature remain. Many existing studies are short-term, leaving questions about the sustainability of immersive media's effects on learning over extended periods. Moreover, most research focuses on primary and secondary education, with less attention to post-secondary or adult learners (Smeda, Dakich, & Sharda, 2014). Another limitation lies in the inconsistency of evaluation measures. Studies variously assess success through academic performance, engagement levels, or affective responses, making cross-comparison difficult. Standardised metrics would help synthesise findings across different contexts and methodologies.

A further concern is the predominance of research conducted in well-resourced educational environments. This leaves a knowledge gap regarding the feasibility and impact of immersive tools in under-resourced schools, where infrastructure, training, and technical support may be limited. Investigating these contexts is crucial to understanding the broader applicability of digital storytelling and immersive technologies.

The literature demonstrates that digital storytelling, supported by animation and immersive tools such as VR and AR, can significantly enhance learning by fostering engagement, improving comprehension, and strengthening memory retention. The theoretical foundations provided by Mayer's Cognitive Theory of Multimedia Learning, alongside empirical studies in diverse settings, suggest that when implemented with thoughtful design, these tools can provide meaningful educational benefits. However, further research addressing long-term impacts, diverse learner populations, and equitable access is necessary to develop a more comprehensive understanding of their potential and limitations.

Methodology

This study employed a mixed-method design to examine the impact of animation and immersive media, specifically Virtual Reality (VR) and Augmented Reality (AR), on student learning and engagement in a classroom setting. The mixed-method approach enabled a comprehensive analysis, combining quantitative data to assess academic performance and engagement with qualitative insights into students' emotional and cognitive responses (Creswell & Plano Clark, 2018).

The research design was adapted from Smeda, Dakich, and Sharda (2014), who integrated digital storytelling into classroom teaching and demonstrated that the combination of visual narratives and interactivity could enhance learning outcomes and student interest.

Participants

Participants were 46 students from two classrooms in a local school, with an even gender distribution and similar academic performance based on the previous term's results. The study spanned a six-week learning module. One class received traditional instruction (control group), while the other engaged with immersive media-enhanced lessons (experimental group).

The sample selection was informed by the classroom project model of Liu et al. (2014), which involved sixth-grade students (aged approximately 11–12) in Taiwan. Both classes in the present study followed the same curriculum, with immersive media integration serving as the sole instructional variable.

Tools and Technology Used

The technology selection was informed by prior educational interventions and tailored to national curriculum standards. Each activity reinforced, rather than replaced, existing lesson plans.

- **Animation Software:** Vyond and Adobe Animate were used to create animated characters and digital narratives for science and literacy topics, following the approach in Smeda et al. (2014).
- **Virtual Reality (VR):** Inspired by Parong and Mayer (2018), VR simulations of environments such as rainforest ecosystems and the solar system were delivered using Oculus Rift headsets.
- **Augmented Reality (AR):** Following Radu's (2014) model, AR apps such as Quiver and Merge Cube enabled students to interact with 3D models of mathematical and scientific concepts.
- **Supporting Tools:** Google Forms for surveys, Seesaw for journaling, and Kahoot! for formative quizzes were integrated to facilitate data collection during class.

Lesson Design

Drawing on Wu, Lee, Chang, and Liang (2013), the lessons focused on science, English, and mathematics. Examples included:

- **Science:** An animated digestive system journey modelled on Parong and Mayer's (2018) VR biology lessons.
- **Mathematics:** AR-based geometric transformations, allowing students to rotate and resize shapes in 3D space.
- **English:** Animated storytelling projects, inspired by Smeda et al. (2014), where students wrote and animated short narratives using tools such as Scratch.

A flipped-classroom model was used: students accessed animated or immersive media content as homework and then engaged in in-class discussions and activities.

Data Collection

Data were collected through both quantitative and qualitative measures:

Quantitative:

- Pre- and post-tests modelled on Wu et al. (2013) assessed subject-specific knowledge and cognitive skills.
- A modified Student Engagement Instrument (Appleton et al., 2006) measured emotional, behavioural, and cognitive engagement on a five-point Likert scale.

Qualitative:

- Weekly student reflections, teacher interviews, and short surveys captured perceptions of motivation, comprehension, and enjoyment.
- Structured observation rubrics, adapted from Parong and Mayer (2018), recorded signs of attention, participation, and collaboration. Two independent observers monitored both classrooms to minimise bias.

Data Analysis

Quantitative data were processed using SPSS. Paired t-tests measured within-group improvements, and independent-samples t-tests compared outcomes between groups, with statistical significance set at $p < 0.05$.

Qualitative data were analysed thematically following Braun and Clarke (2006). Recurring themes, such as "*It helped me see things clearly*" or "*I felt like I was inside the lesson*," were identified. Teacher journals and classroom notes were used for triangulation.

Validity and Reliability

To ensure methodological rigour:

- Instruments were drawn from validated tools (Appleton et al., 2006; Fredricks et al., 2004).
- Lesson plans for both groups maintained identical content and timing.
- Observers and coders were blinded to classroom group assignments.
- Cronbach's alpha for the engagement scale was 0.91, indicating high internal consistency.

Limitations

The study faced several practical constraints:

- Students new to VR required orientation sessions, reducing available instructional time.
- Limited device availability necessitated turn-taking for VR and AR experiences.
- A small number of students initially found animations distracting, requiring teacher-led strategies to maintain focus.

Despite these limitations, the results indicated notable gains in engagement, conceptual understanding, and knowledge retention for the experimental group.

Ethical Considerations

Ethical approval was secured in accordance with institutional standards. Parental consent was obtained for all participants, and anonymity was preserved throughout data handling. Students retained the right to withdraw at any stage. All digital materials used in the study complied with relevant data protection and privacy policies.

Results

Findings are presented across four main areas: student engagement, academic performance, student feedback, and classroom observations. These outcomes draw on validated instruments and the practical implementation models described in the methodology.

Changes in Student Engagement

Engagement, a key indicator of learning success, improved notably following the integration of animation and immersive tools. Quantitative data from the modified Student Engagement Instrument (SEI) (Appleton et al., 2006) showed significant increases in all three domains: emotional engagement rose from 3.1 to 3.9, behavioural engagement from 3.1 to 4.0, and cognitive engagement from 3.1 to 3.8 on a five-point scale.

These results align with prior studies. Ibáñez et al. (2014) reported higher engagement in students using AR-based chemistry apps, while Cheng and Tsai (2013) observed similar outcomes in VR-supported science learning. In this study, teachers noted that students interacting with VR and AR content remained focused for longer periods. For example, during an animated 3D digestive system lesson, one teacher remarked: *"Usually, I have to call their names to get their attention, but today, they were raising hands before I even asked questions."*

Academic Performance: Pre- and Post-Intervention Tests

Academic performance was measured through pre- and post-tests assessing comprehension, retention, and application. In the experimental group (animation, AR, and VR), average scores increased from 67% to 84%. The control group improved from 66% to 74%.

The 10-point performance gap mirrors prior findings. Wu et al. (2013) reported higher post-test scores among students learning science with AR, while Parong and Mayer (2018) found VR-enhanced biology lessons improved recall and transfer tasks. Statistical analysis confirmed the significance of these results ($p < 0.05$), with an effect size of 0.84, indicating a large positive impact.

In mathematics, students using AR to manipulate 3D shapes performed better on spatial reasoning tasks, supporting Radu's (2014) conclusion that AR is particularly effective for visualising abstract concepts.

Student Feedback

Qualitative feedback, gathered from weekly reflections and short surveys, was analysed thematically (Braun & Clarke, 2006), revealing three recurrent themes:

> **"I could finally see it."**
> Students reported that animations and immersive visuals clarified previously confusing topics. One noted: *"I always thought the food just goes to the stomach and disappears. But seeing it move step by step in the animation made it click."* Another, after a VR rainforest exploration, wrote: *"It felt like I was walking through the forest myself. I saw how everything was connected… I understood it better than from pictures in the book."*
>
> **"It's like playing, but learning."**
> AR tools such as Merge Cube and Quiver made learning more interactive and enjoyable. A student shared: *"I was holding the volcano in my hand… I forgot I was learning."* This echoes Smeda et al. (2014), where students described digital storytelling as both engaging and educational.
>
> **"I felt more confident."**
> Many reported greater willingness to participate in discussions. As one explained: *"Usually I'm shy to answer. But after watching the video at home, I knew what was*

coming. I talked more in class." This reflects benefits identified by Bergmann and Sams (2012) in flipped- classroom settings.

Teacher Perspectives and Observations

Structured observations (Parong & Mayer, 2018) and teacher interviews indicated that the experimental group displayed higher participation rates, asked more follow-up questions, used subject-specific vocabulary more frequently, and engaged in peer discussion.

Teachers noted that immersive tools supported lower-performing students by providing concrete reference points. One science teacher remarked: *"Some of my weaker students usually stay quiet, but once they had the animation as a reference, they started answering questions."*

This is consistent with the Universal Design for Learning (UDL) framework (CAST, 2018), which advocates for multiple means of representation to accommodate diverse learners.

Engagement Over Time

A potential concern with digital tools is novelty fatigue. However, engagement remained steady or improved over the six weeks. During the final AR mathematics lesson, "fun" and "helpfulness" ratings averaged 4.6/5, slightly above earlier lessons. This mirrors Parong and Mayer's (2018) finding that repeated VR exposure can enhance rather than diminish learning as students become more adept at navigating the technology.

Challenges Observed

While results were largely positive, several challenges emerged:

- **Technical issues** occasionally disrupted lessons, and some students experienced difficulty adapting to VR controls or reported motion sickness. Teachers needed to allocate time for setup and troubleshooting, consistent with the concerns raised by Bower et al. (2014).
- **Variable learner responses** were noted, with a few students finding animations too fast-paced or distracting. This reflects Mayer's (2005) caution that poorly structured visuals may overwhelm learners. In response, teachers paused animations at key points and synchronised captions with narration to support varied learning preferences.

Visual Summary of Results

- **Engagement Scores:** Increased by 25–30% across emotional, behavioural, and cognitive domains.
- **Academic Performance:** Experimental group improved by 17 percentage points; control

Group by 8.

- **Participation Rates:** 40% increase in contributions during discussions in the experimental Group.
- **Frequent Feedback Themes:** "I could see it" and "It felt real."

These findings align with previous research (Di Serio et al., 2013; Cheng & Tsai, 2013; Radu, 2014) and suggest that immersive tools can be both engaging and pedagogically effective.

In summary, integrating animation and immersive media led to:

- Increased emotional and behavioural engagement.
- Improved academic outcomes, particularly in science and mathematics.
- Higher classroom participation and confidence among students.
- Strong student satisfaction and positive emotional responses.

Although technical and logistical challenges were present, the combination of statistically significant performance gains and consistent qualitative enthusiasm supports the potential of immersive media as a meaningful addition to everyday teaching practice.

Discussion

This study provides valuable insights into the role of animation, Virtual Reality (VR), and Augmented Reality (AR) in reshaping classroom learning experiences. While prior research has demonstrated the benefits of these tools (Smeda, Dakich, & Sharda, 2014; Parong & Mayer, 2018; Wu, Lee, Chang, & Liang, 2013), the present findings extend understanding by illustrating how immersive media can enhance both cognitive outcomes and emotional engagement when applied in a balanced, curriculum-aligned manner.

Engagement: More Than Just Fun

A prominent outcome was the significant improvement in student engagement among those using immersive learning tools. This supports Radu's (2014) conclusion that AR can increase curiosity and time-on-task in science education. Student reflections such as *"I feel like I'm inside the story"* or *"It doesn't feel like studying"* point to deep emotional and cognitive involvement.

Parong and Mayer (2018) noted that VR fosters understanding of complex systems by increasing a learner's sense of presence. The VR rainforest experience was frequently described in journals as "cool" and "easier to remember than reading." Students were not merely entertained; they were participating in learning in ways they perceived as personal and active. This is consistent with

Fredricks, Blumenfeld, and Paris (2004), who view engagement as comprising interrelated emotional, behavioural, and cognitive dimensions.

In contrast, students in the control group exhibited lower enthusiasm and participation, suggesting that traditional methods, while still effective for some, may not cater to the range of learning preferences in today's classrooms.

Understanding and Memory Retention

The study also found that immersive tools improved students' grasp of complex concepts and supported memory retention. The animated digestive system lesson, modelled on Parong and Mayer's (2018) VR biology approach, was repeatedly cited as helping students "see what's happening inside" and "making it stick."

These observations align with Mayer's (2005) Cognitive Theory of Multimedia Learning, which posits that combining visual, auditory, and spatial information meaningfully strengthens mental models. Importantly, the content was designed in line with Mayer's coherence principle, avoiding extraneous effects that might overload learners.

Pre- and post-test results reinforced these perceptions, particularly in the experimental group, mirroring Wu et al.'s (2013) findings that AR-based science learning can outperform traditional instruction.

Student Voice and Motivation

The integration of digital storytelling assignments fostered student autonomy and intrinsic motivation. Inspired by Smeda et al. (2014), students were encouraged to script and animate their own narratives using Scratch and Vyond. Many invested extra time outside class refining their work, suggesting heightened ownership over learning.

This reflects Deci and Ryan's Self-Determination Theory (2000), which emphasises the role of autonomy, competence, and relatedness in intrinsic motivation. As one student noted: *"I'm not good at drawing, but with Vyond, I can show my ideas."* Such platforms provide inclusive opportunities for diverse learners to express themselves confidently.

Teacher Reflections and Classroom Dynamics

Teacher interviews corroborated these findings. Immersive sessions were associated with higher attentiveness, collaboration, and inquiry. Merge Cubes, in particular, made abstract mathematical

concepts more tangible, and students with weaker spatial reasoning demonstrated noticeable gains in understanding and confidence.

Logistical challenges were acknowledged, including managing headset time and troubleshooting technical issues, echoing concerns in Huang, Rauch, and Liaw (2010) and Radianti et al. (2020). Nevertheless, teachers felt these challenges were outweighed by the benefits, particularly when learners received structured orientation and ongoing support.

Technology as a Bridge, not a Crutch

The findings reinforce that immersive tools should complement, not replace, core teaching methods. This is consistent with Cheng and Tsai (2013), who found that AR/VR is most effective when integrated purposefully into curriculum objectives.

In this study, the flipped-classroom strategy allowed students to explore interactive content at their own pace before engaging in teacher-facilitated discussions. This approach shifted teachers from the role of content deliverers to facilitators of deeper inquiry, often leading to more profound conceptual understanding.

Unexpected Outcomes

Not all findings were anticipated. Some students initially found immersive media distracting, aligning with Liu et al.'s (2014) observation that learners unfamiliar with highly visual environments may focus on the medium rather than the message. This was addressed through brief training sessions and gradual integration.

A positive and unexpected development was the emergence of peer-to-peer support. In VR activities, students often guided each other through technical tasks, creating a collaborative environment that resonates with Vygotsky's (1978) social development theory. The sharing of tips, problem-solving strategies, and encouragement enriched the social dimension of learning.

Bridging the Digital Divide

Equity of access remains a critical concern. While high-end VR and AR tools may be beyond the budgets of many schools, this study, supported by similar conclusions from Ibáñez and Delgado-Kloos (2018), demonstrates that more affordable options, such as mobile-based AR and free available animation tools can still produce significant learning benefits.

Even students with limited prior exposure to technology adapted quickly when provided with scaffolded learning and clear instructions. This suggests that thoughtful integration of immersive media can help narrow, rather than widen, the digital divide.

Limitations and Opportunities for Future Research

Several limitations should be acknowledged. The small sample size and six-week duration limit the generalisability of findings and prevent assessment of long-term retention. Similar concerns were raised by Di Serio, Ibáñez, and Kloos (2013), who called for longitudinal studies.

The potential influence of novelty cannot be discounted; engagement levels may have been partially driven by the excitement of new tools. Future research should explore whether sustained exposure maintains, increases, or diminishes motivation.

Additionally, further work is needed to investigate the effects of immersive media on different learner types, including those with learning disabilities, and to examine comparative benefits for visual versus auditory learners.

Implications for Educators

Despite these constraints, the findings hold practical value for educators. Animation, AR, and VR can meaningfully enhance lesson delivery, making concepts more accessible, stimulating curiosity, and encouraging collaboration and self-expression.

For teachers new to immersive media, the key recommendations are to start small, integrate tools purposefully into existing lesson plans, and use free or low-cost resources such as Scratch, Quiver, and YouTube's 360° videos. Even limited applications can create substantial learning gains when used strategically.

In summary, education is fundamentally about building connections—between students and knowledge, between peers, and between what is taught and what is remembered. When applied with clear pedagogical intent, immersive media can strengthen these connections by transforming lessons into vivid, memorable experiences.

Rather than competing with the technology-rich environments in which students already live, educators can harness these tools to inspire curiosity, deepen understanding, and create classrooms that are not only spaces for instruction but also spaces for exploration.

Conclusion

This study examined how immersive media, particularly animation, Virtual Reality (VR), and Augmented Reality (AR), can enhance educational storytelling in classroom settings. Findings indicate that when thoughtfully integrated into the curriculum, these tools are more than technological enhancements; they can meaningfully transform stories, concepts, and abstract ideas into engaging, memorable learning experiences.

Storytelling has always been central to education, and immersive technologies extend its potential by engaging multiple senses and learning pathways. Animation adds motion and emotion to content, VR places students within a scene, and AR blends digital and physical worlds. Together, they encourage active participation, strengthen conceptual understanding, and stimulate creativity. In this study, students exposed to immersive content demonstrated consistently higher engagement, improved comprehension, and a greater willingness to explore topics beyond the classroom.

The role of the teacher remains critical. The most successful outcomes occurred when educators acted as facilitators, guiding students in connecting immersive experiences with learning objectives. Purposeful integration, combined with strategies such as flipped learning, ensured that technology complemented rather than replaced core teaching methods.

While cost and access remain challenges, results show that even low-cost tools such as mobile AR applications, Scratch, or Quiver can deliver meaningful impact when implemented with intent. Equity in access requires careful planning, shared resources, and teacher training, enabling schools to adopt immersive media progressively without widening the digital divide.

The study's limitations include a small, context-specific sample, a short intervention period, and the potential novelty effect. Technical issues such as device limitations and software glitches also affected delivery. Future research should investigate long-term retention, impacts on diverse learner groups, and the sustainability of engagement as technology becomes familiar.

For educators, starting with a small number of tools, investing in teacher training, encouraging student- generated content, and blending traditional and immersive methods can provide significant benefits. Policymakers can support these initiatives through targeted funding, infrastructure development, and the promotion of scalable pilot programmes.

Ultimately, education is about creating connections, between students and knowledge, between peers, and between what is taught and what is remembered. When used with pedagogical intent,

immersive media can strengthen these connections, transforming lessons into experiences that inspire curiosity, deepen understanding, and foster a lifelong love of learning.

References

[1] Appleton, J. J., Christenson, S. L., Kim, D., & Reschly, A. L. (2006). Measuring cognitive and psychological engagement: Validation of the Student Engagement Instrument. *Journal of School Psychology, 44*(5), 427–445.

[2] Bergmann, J., & Sams, A. (2012). *Flip your classroom: Reach every student in every class every day*. ISTE.

[3] Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101.

[4] Bruner, J. (1991). The narrative construction of reality. *Critical Inquiry, 18*(1), 1–21.

[5] CAST. (2018). *Universal Design for Learning Guidelines (Version 2.2)*. CAST.

[6] Cheng, K.-H., & Tsai, C.-C. (2013). Affordances of augmented reality in science learning: Suggestions for future research. *Journal of Science Education and Technology, 22*(4), 449–462.

[7] Clark, R. E. (1983). Reconsidering research on learning from media. *Review of Educational Research, 53*(4), 445–459.

[8] Creswell, J. W., & Plano Clark, V. L. (2018). *Designing and conducting mixed methods research* (3rd ed.). SAGE.

[9] Deci, E. L., & Ryan, R. M. (2000). The "what" and "why" of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 11*(4), 227–268.

[10] Di Serio, Á., Ibáñez, M. B., & Kloos, C. D. (2013). Impact of an augmented reality system on students' motivation for a visual art course. *Computers & Education, 68*, 586–596.

[11] Fredricks, J. A., Blumenfeld, P. C., & Paris, A. H. (2004). School engagement: Potential of the concept, state of the evidence. *Review of Educational Research, 74*(1), 59–109.

[12] Huang, H.-M., Rauch, U., & Liaw, S.-S. (2010). Investigating learners' attitudes toward virtual reality learning environments: Based on a constructivist approach. *Computers & Education, 55*(3), 1171–1182.

[13] Ibáñez, M. B., & Delgado-Kloos, C. (2018). Augmented reality for STEM learning: A systematic review. *Computers & Education, 123*, 109–123.

[14] Kiessling, K. (2024). Rockwell Museum launches free, virtual field trip program. *Times Union*.

[15] Kirkland, J. (2024). Design students fast-tracked into $80 billion industry via on-campus studio. University of the Sunshine Coast.

[16] Liu, T.-C., Lin, Y.-C., Tsai, M.-J., & Paas, F. (2014). Split-attention and redundancy effects in multimedia learning: A perspective from cognitive load theory. *Computers & Education, 77*, 117–125.

[17] Liu, T.-C., Lin, Y.-C., Tsai, M.-J., & Paas, F. (2014). Split-attention and redundancy effects on mobile learning in physical environments. *Computers & Education, 72*, 339–351.

[18] Mayer, R. E. (2005). Cognitive theory of multimedia learning. In R. E. Mayer (Ed.), *The Cambridge handbook of multimedia learning* (pp. 31–48). Cambridge University Press.

[19] Nam, C. W. (2016). The power of digital storytelling to support teaching and learning. *Interactive Learning Environments, 24*(6), 1231–1245.

[20] Niemi, H., & Niu, S. J. (2021). Effects of digital storytelling on student engagement and learning outcomes: A meta-analysis. *Australian Journal of Education, 65*(1), 24–41.

[21] Parong, J., & Mayer, R. E. (2018). Learning science in immersive virtual reality. *Journal of Educational Psychology, 110*(6), 785–797.

[22] Radu, I. (2014). Augmented reality in education: A meta-review and cross-media analysis. *Personal and Ubiquitous Computing, 18*(6), 1533–1543.

[23] Radianti, J., Majchrzak, T. A., Fromm, J., & Wohlgenannt, I. (2020). A systematic review of immersive virtual reality applications for higher education: Design elements, lessons learned, and research agenda. *Computers & Education, 147*, 103778.

[24] Rashid, N., Khanum, N., & Raheem, F. (2023). The effect of animation as a teaching tool on students' learning: An experimental study. *Educational Psychology Review*.

[25] *The Guardian*. (2025). The startup bringing virtual reality into Australian classrooms.

[26] Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

[27] Wu, H.-K., Lee, S. W.-Y., Chang, H.-Y., & Liang, J.-C. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers & Education, 62*, 41–49.

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Authors' Bio

Teo Yu-Xuan is a passionate Animation student currently pursuing her studies at Multimedia University, Malaysia. With a strong enthusiasm for the world of digital creativity, she has developed a keen interest in multimedia design, as well as both 2D and 3D animation. Her academic journey and hands-on experiences have allowed her to build a solid foundation in visual storytelling, enabling her to effectively convey compelling narratives through animated visuals. Teo's work reflects a blend of technical skill and artistic expression, showcasing her dedication to the craft. She continues to explore innovative approaches to animation, striving to grow as a creative professional in the industry.

Geuan Jun Wei an Immersive Media Design student at Multimedia University, Malaysia, with a solid academic foundation in Information Technology. His passion lies at the intersection of immersive design and cutting-edge digital innovation, particularly in the areas of Augmented Reality (AR) and Virtual Reality (VR). Drawing from his IT background, Jun Wei approaches immersive media with a unique blend of technical proficiency and creative vision. He is especially interested in exploring how AR and VR can enhance user experiences, transform storytelling, and redefine digital interaction. With a forward-thinking mindset, he continuously seeks opportunities to experiment with emerging tools and technologies that push the boundaries of immersive design.