MALAYSIAN ONLINE JOURNAL OF EDUCATIONAL MANAGEMENT (MOJEM)

JANUARY 2026, VOLUME 14, ISSUE 1, 61-71
E-ISSN NO: 2289 – 4489

DIGITAL LEADERSHIP IN VR-BASED EXPERIENTIAL LEARNING: CHALLENGES AND STRATEGIC DIRECTIONS IN HIGHER EDUCATION DECORATIVE MATERIALS EDUCATION

Ke Zhang[1], *Ruethai Nimnoi[2], & Ratanachote Thienmongkol[1]

[1]
Department of New Media, Faculty of Informatics, Mahasarakham University, Mahasarakham Province, Thailand, 44150

[2]
Department of Information Science, Faculty of Informatics, Mahasarakham University, Mahasarakham Province, Thailand, 44150

Corresponding Author:
ruethai.n@msu.ac.th

ABSTRACT

The project studies digital leadership challenges as well as AI leadership challenges incorporated with virtual reality in a practice-based higher education, with the applied area being Decorativematerials education. The DML-ELVR (Decorative materials learning - experiential learning in virtual reality) framework was designed and examined against substantial problems like limited resources, quality guarantees, and compatibility between technology and instruction in education administration. A mixed-method quasi-experimental study was done to randomly allocate the total sample size of 70 undergraduate students as a VR-based experimental group n=35 & 35 in a traditional control group. Quantitative data from the DMST/validated scales (e.g., LTM, TMI, etc.) will be analyzed using ANCOVA. Qualitative data will be collected via the use of semi-structured interviews with students, as well as class observation. Experimental groups scored higher than control groups on material cognition, design visualization, and applied practice ($p<0.01$). The study has also recognized many problems related to digital/AI leadership in higher education management and provides solutions. These issues include technology integration problems, staff capability development problems, and institutional resource allocation problems. DML-ELVR framework gives an evidence-based guide for the educational managers about digital transformation. So that VR innovations can have both technology and education.

Keywords: **Digital leadership, AI leadership, educational management challenges, VR-based experiential learning, higher education, decorative materials education.**

MALAYSIAN ONLINE JOURNAL OF EDUCATIONAL MANAGEMENT (MOJEM)

INTRODUCTION

Digital Leadership Challenges in Practice-based Higher Education

The current state of higher education management is highly pressured to implement digital technology in practice-oriented programs such as architecture, design, and engineering, which are grounded in costly laboratory/studio models with expensive infrastructure, equipment, and materials (Gulyamov et al., 2024). Educational managers find that the most important digital leadership question is how to balance technological accessibility (more technology, but fewer resources) and standard quality (every group has the same results). Similar to decoration material education, which is very traditional with site visitations and usage of physical samples as models, it is too costly to be copied, too difficult to be standardized. It needs someone who is a digital leader who could come up with good ideas.

VR as a Strategic Tool: Digital Leadership in Motion

VR and other immersive technologies have become a potential solution for addressing resource limitations to affordably provide authentic practice at close to zero marginal cost (Farouk et al., 2024). However, for them to really work, it takes more than just adopting the technology. Managers need to fit VR tools to curriculum goals, improve faculty skills, and create support systems across all levels of the school. AI leadership is added on by personal learning paths, immediate performance stats, and predicting quality assurances. Those opportunities go unused because there are not enough technology-pedagogy leaders.

Gaps in Digital/AI Leadership for VR Integration

Previous VR education studies have examined student results or technological acceptance. Yet, leadership aspects in running a VR-based learning program have been overlooked (Nortvig et al., 2020). Digital leadership remains on how they can include VR into the program curricula without dismantling them, how to build faculty's digital literacy for experiential VR learning, and what would be the allocation of resources of an institution for VR labs. Plus, deficiencies related to AI leadership with regard to using data-driven insights to improve VR learning. These are central in solving the two main problems that education management faces: efficacy and quality.

In this study, digital leadership is conceptualized as institutional governance encompassing strategic planning, resource allocation, faculty capacity building, and curriculum alignment, while AI leadership refers specifically to data-driven leadership practices such as learning analytics, personalized feedback, and ethical data governance. These leadership dimensions are explicitly mapped onto the stages of experiential learning (concrete experience, reflective observation, abstract conceptualization, and active experimentation), strengthening theoretical coherence (Kolb & Kolb, 2006; Marks & Thomas, 2022).

Research Aim and Contributions

The study was made out of challenges related to digital or AI leadership, and for that reason, the DML-ELVR Framework, developed using VR-based Experiential Learning and Kolbs Learning Cycle, will be employed. It makes contributions to the education administration. It has at least three significant impacts on education administration:

1. Determine key digital/AI leadership issues in VR integration for practice-based programs;
2. Present examples or evidence of the structured frameworks easing these difficulties and enhancing student learning.
3. Provide feasible strategies for educational managers to improve their digital leadership ability, match AI tools to teaching objectives, and keep up with tech innovations.

OBJECTIVES

The main aim is to create and examine a virtual laboratory framework for students' learning experience in practice-oriented higher education courses. Decorative materials education was used as the applied context to learn what can be applied to other disciplines that rely on labs or experiential learning. Hence, the specific purpose: this study enables the researcher to achieve the following three main aspects:

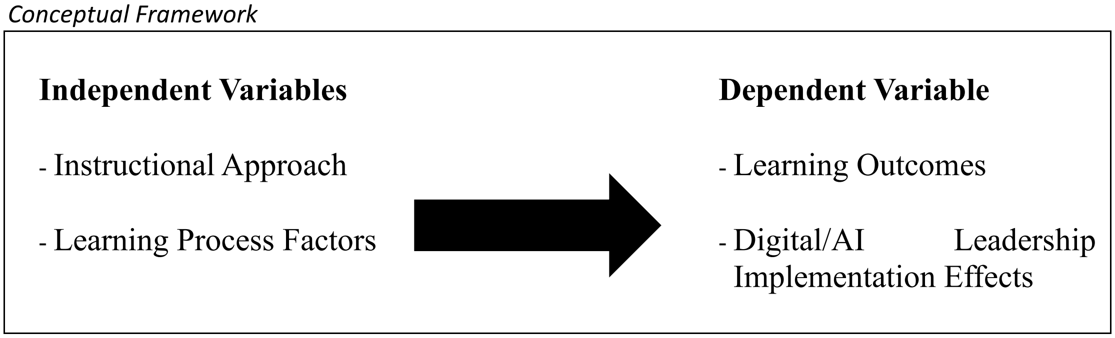
1. Develop a system that integrates virtual lab tools seamlessly into the classroom to enhance students' motivation, creativity, and skills development (AlGerafi et al., 2023).
2. Evaluate the system's effectiveness from various aspects, such as cognitive understanding, practical application, learning experiences, and academic results (Biggs, 1993).
3. Analyze the implementation path of integrating virtual reality laboratories in the decoration materials course under the support of the college and the curriculum department, as well as the positive effects on the improvement of teaching quality (Marks & Thomas, 2022).

To identify key digital/AI leadership issues regarding VR integration in practice-based programs, and find ways to overcome challenges like a lack of resources and insufficient faculty digital literacy.

5. To examine the likelihood of AI tools improving VR-based experiential learning, such as personalizing learning support and offering real-time performance analysis, while dealing with major hurdles like worries about data privacy and lack of technical expertise.

CONCEPTUAL FRAMEWORK

Figure 1
Conceptual Framework



RESEARCH METHODOLOGY

Research Design
Mixed-method quasi-experimental research design is used to compare the VR-based instruction (experimental group) with traditional instruction (control group), focusing on learning outcomes and digital leadership implementation barriers.

Participants
Seventy undergraduates from the School of Architecture and Arts (2-4, 55.7% male, 78.6% aged 20) from a random group (n=35). Both groups were taught by a teacher with 5+ years of experience to control for variation in teaching.

Table 1
Demographic Characteristics of Participants

Basic information category	Classification	Number of people	percentage
Gender	Male	39	55.70%
	Female	31	44.30%
Age	19	5	7.14%

	20	55	78.57%
	21	10	14.29%
	2nd years	5	7.14%
Grade	3nd years	55	78.57%
	4nd years	10	14.29%

Table 2

Demographic Characteristics of Experimental and Control Groups

Basic information category		Experimental group		Control group	
		Number of people	percentage	Number of people	percentage
Gender	Male	19	54.29%	20	57.14%
	Female	16	45.71%	15	42.86%
Age	19	2	57.14%	3	85.71%
	20	22	62.86%	23	65.71%
	21	5	14.29%	5	14.29%
Grade	2nd years	3	85.71%	2	57.14%
	3nd years	28	80.00%	27	77.14%
	4nd years	5	14.26%	5	14.29%

Instruments

To address the editorials related to digital / AI Leadership challenges. The following instruments were used:

Decorative Materials Skills Test (DMST) (Cronbach'sα=0.79 – 0.85). Material cognition, design visualization, and applied practice (core learning results of VR integration).

DLIS (Digital Leadership Implementation Survey, adapted from Marks and Thomas, 2022). 5-point Likert scale (Cronbach's alpha =.88), faculty perceptions of digital leadership implementation challenge (resource allocation, training support, curriculum alignment).

ALPA (AI Leadership Potential Assessment). Assess the potential for integrating AI (personalized feedback, performance analytics) and the obstacles (data privacy concerns, technical expertise shortage).

Semi-structured Interviews. Faculty and students, digital leadership gaps (what did the institution lack to have effective VR use?), and AI leadership needs (how could AI tools improve your learning experience?).

Classroom Observations. Technology snags (equipment downtime, software glitches), instructor fixes, and institution help.

Data Collection

Data was collected over the 8-week intervention:

Pre-Test (Week 1). DMST baseline test, DLIS, and ALPA administered to faculty/students.

Intervention (Weeks 2-7). Experimental group: using the DML-ELVR framework to perform VR-based tasks (material selection, 3D modeling, iterative design). Control group: traditional lectures and physical samples. Observations tracked digital leadership issues (e.g., faculty training needs, resource shortfalls).

Post-test (Week 8). DMST retest; follow-up DLIS/ALPA survey; semi-structured interviews with experimental group students and instructor.

Data Analysis

Quantitative. ANCOVA with pre-test scores as covariates to compare learning outcomes between groups, descriptive statistics for DLIS/ALPA digital/AI leadership challenge data.

Qualitative. Interviews/observations thematic analysis found recurring barriers (inadequate training) and solutions (professional development).

RESULTS

Learning Outcomes: VR's Effectiveness

In the pre-test, there was no significant group difference ($t = 1.24$, $p > 0.05$). Post-test ANCOVA indicated that the experimental group significantly outperformed the control group on all skills dimensions, $F(1, 29)=18.45$, $p<.01$:

Table 3

Pre- and Post-Test Results for the Experimental and Control Groups by Skill Dimension

Skill Dimension	Experimental group	Control group	Difference	Improvement Rate
Material Cognition (MC)	87.4	72.1	15.30%	15.30%
Design visualization capabilities (DV)	83.9	65.7	18.20%	18.20%
Practical operation ability (PA)	89.2	69.4	19.80%	19.80%

Table 4

Comprehensive Skill Improvement of Experimental and Control Groups

Group	Pre-test mean (SD)	Post-test mean (SD)	Absolute Improvement	Relative Improvement
Experimental Group	58.12 (6.4)	85.43 (5.78)	27.31	47.00%
Control group	57.89 (6.2)	68.32 (6.02)	10.43	18.10%

Digital Leadership Challenges Identified

Quantitative and qualitative data revealed three key digital leadership obstacles in education management, the distribution is given in Table 5:

Table 5

Distribution of Digital Leadership Challenges (N=40, Faculty + Students)

Digital Leadership Challenge	Frequency	Percentage	Key Manifestations
Insufficient Institutional Resource Allocation	27	67.5%	Lack of VR maintenance budget, limited technical support staff
Faculty Digital Literacy Gaps	29	72.5%	Inability to guide VR troubleshooting, lack of structured digital teaching

Digital Leadership Challenge	Frequency	Percentage	Key Manifestations
			training
Difficulties in Curriculum Alignment	25	62.5%	Conflict between VR tasks and existing syllabus timelines, mismatched assessment

AI Leadership Chances and Barriers
ALPA data and interviews found untapped AI potential and challenges, with group cross-perceptions as in Table 6:

Table 6
AI Leadership Opportunities and Barriers (perception rate, n = 40)

AI Leadership Dimension	Positive Perception (Opportunity)	Negative Perception (Barrier)	Specific Feedback
Personalized Learning Support	75.0%	25.0%	"AI-driven feedback could tailor design guidance to individual skill gaps"
Real-Time Performance Analytics	70.0%	30.0%	"AI could help track class-wide progress, but data privacy is a concern"
Technical Expertise Gaps	23.0%	77.0%	"Institution lacks staff trained to integrate AI with VR tools"
Data Privacy Risks	18.0%	82.0%	"Student design data stored for AI analysis may be vulnerable to breaches"

DISCUSSION

This discussion section focuses on interpreting key findings through a leadership lens, explicitly linking empirical results to implications for digital and AI leadership practices in higher education management, particularly in relation to strategic resource planning, faculty development, and curriculum governance (Farouk et al., 2024; Nortvig et al., 2020).

Digital Leadership Facing Education Management Core Challenges
DML - ELVR works with empirics to show that digital leaders in high-tech education is not technology, it’s the whole system of governing education to solve 3 big problems like there are some of these not being used, and some of them not being watched over well enough for what you are teaching and how you teach it, which means that VR is more than just to have and should be important when you want to learn. That would mean someone thought of it consciously.

Strategic Resource Management. Staring at the results from the study, it becomes evident that resource limitations are not just about having or not having money. It is also an inability to function and strategize. Educational managers need to go beyond one-time allocations for VR hardware and create lasting ecosystems for resources. Also included in this is a line item for proactive maintenance on all of the equipment downtime that was observed in classrooms; fully staffed technical support teams that have been trained to tackle VR-related issues; and scaling licensing for educational software. VRLabs needs to be treated as a strategic piece of infrastructure, like the traditional lab does with resource planning put into the institutional strategic plan, not short-term grants, Farouk et al. (2024) argue. The digital leader has to decide if it is better to have it for access or quality. In order for the VR tool to get used in different cohorts, there would be no need to have that same thing and not have those special machines, and if you get cloud VR, you should be able to have the same feel.

Faculty Capacity Building. the 72.5% of the prevalence of the difference in digital literacy between faculties in table 5, which indicates that most difficulties of digital leaders do not come directly from technology but rather a lack of human resources. Effective leadership is not a one-time training workshop. The goal is to build long-term capacity in two areas: VR pedagogical design and technical troubleshooting. Digital leaders must build layered PD programs, including peer mentoring and communities of practice. Faculty need an immersive training setting to become learners of VR and to close skills and pedagogy gaps. For example, workshops about VR tasks fitting into the learning cycle of Kolb, which is a major part of DML-ElVr, can be used for teachers to make hands-on activities for their students to learn about the material and practice it better. Like the skill gap, though, leaders also need to close "the confidence gap" - faculty confident in support, like troubleshooting if the tech is on call, or equipment prepping before class, will be more enthusiastic about regularly using VR in their lessons.

Curriculum Integration Leadership. Table 5, where 62.5% said it was difficult to align the curriculum, indicates that digital leadership should integrate the curriculum instead of just adding technology. Managers have to guide program coordinators to blend VR into the fabric of course syllabi. VR tasks are made to be in sync with learning outcomes, evaluation rubrics, and programmatic accreditation standards. It demands a sort of leadership that could promote cross-department collaboration, a kind of collaboration between curriculum designers, techies, and teachers, ensuring that VR activities go with the flow of existing teaching sequences rather than break them up. Such as including VR-based material testing as part of the education for decorative materials, the evaluation of the design project will consist of both the technical aspect (DMST) and the creative element (portfolio review). Digital leaders could make some feedback loops to adjust how their curriculum is all meshed up with student performance data and what the faculty has to say, tweaking VR tasks, changing timelines, and sorting out issues between tech capabilities and teaching needs.

AI Leadership: Unleash Your Effortless New Level Efficiency & Quality

AI leadership becomes a good companion to digital leadership: it helps solve what education's most stubborn problem is: getting scalable, personalized, and high-quality education at the same time, which also brought new issues that need governing. In the study's ALPA data (Table 6). There seems to be a contradiction in the figures from people who think AI can personalize learning: 75% of them think it benefits students, yet 82% consider data privacy a risk, implying that AI leaders must lead on innovation and accountability.

Data Governance For Trust And Compliance. AI-led VR learning creates numerous pieces of private information: student design portfolios, right now perf stats, and so on. As such, governing data is key to leading with AI. For educational managers to make policy for the three areas of collecting information on learning outcomes, securing the information, and allowing the use of data, they need to collect information by only taking the necessary information for learning outcomes. Next is to secure the data by encrypting and limiting access to the information, and then use the data by using AI analytics to improve learning outcomes, and not solely to monitor teachers' performance. Working with the institutions' IT and legal departments to make sure it's all GDPR / FERPA (data protection) compliant first, before talking to the students about what they are going to do with their data. For example, the AI that gives back to students their personal feedback on making the visualizations of the design would have all the numbers mixed for all the students in the class, to make things better for everyone, but not know who did what. Leadership will have to deal with the “black box” problem: making sure that the AI algorithm can be explained so that both Faculty members and students understand where the feedback/recommendations came from.

Building Skill in AI Pedagogy Integration. The 77% gap in technical ability (Table 6) also highlights that AI leadership includes creating human capital that can make the link between artificial intelligence and education. It is not by training faculty on AI tools, but by making a team of “AI-pedagogy experts” who can work with faculty to build AI-VR activities, interpret the analytics, and solve integration problems. Educational managers need to emphasize a multi-field training plan: training educational theory for those technical staff for them to understand pedagogical aspects; training basic AI, such as machine learning algorithms and data analytics for those faculty members, so that they can make use of AI tools, training those curriculum designers in aligning AI-driven assessment with learning outcomes, e.g., AI which can auto-grade responses to design visualization feedback and be customized with faculties and professionals aligns with course rubrics. Instructors can have it easy and keep the same answer. AI leadership must cultivate an environment of experimentation: offering seed money for trial projects, rejoicing in the little wins, and making gradual improvements the new normal, understanding that effective AI integration is a journey, not a destination.

Strategic AI Deployment for Systemic Results. AI leaders must avoid "AI for AI’s sake” and strategically deploy AI for education management concerns. Based on the study, the findings show that AI could be used in two main areas: personalization to help the learning process and predicting quality assurance. For personalized learning, AI could look at what students do in VR, like how much time they spend picking out stuff to learn, or the mistakes they make when building 3D stuff, so it can give them special tips just for them. A student has some issues and then gets some help; if the student is very good, they will solve some harder problems. And for quality assurance for AI analytics, we can see the trend as if there is an issue, like a practical skill, then we can change the curriculum and train the teachers. AI leadership also needs to promote equal access to AI-enhanced learning. AI leadership should not use AI tools that are too technical, as they might leave tech-savvy and tech-shy students apart. AI leadership needs to think about how easy it is for students with disabilities to use AI tools.

Furthermore, some do not know or are less familiar with how to use AI technology, so they should also be supported by AI leadership. Also, managers should think about algorithmic bias when they look at the AI tools to make sure that there is fairness in gender, age, and past academics, so that inequality does not continue. Given the integration of AI-supported analytics within VR-based learning environments, this study has explicitly addressed data governance considerations, including data minimization, privacy protection, transparency, and ethical use of student learning data, aligning AI leadership practices with institutional accountability and regulatory expectations (Marks & Thomas, 2022; Pramanik, 2024).

Implications for Educational Managers

To higher educational managers trying to make their way through every twist and turn of digital and AI change, this study has some real-world points that mix new ideas with things that really work in the real world, based on what the DML–ELVR really does.

Framework-driven integration for Digital/AI leadership is the first step. To embrace frameworks such as DML-ELVR, the first step is to afford the means to coordinate resources, faculty expertise, and the curriculum to avoid squandering or misusing resources and achieving no learning outcome. Managers need to try to tailor such frameworks toward their own institution by including key faculty/students/technical staff in the customization of these structures in order to get them to buy in and to be relevant.

Second, develop the GO capability. Digital and AI leadership capacity should be distributed throughout the entirety of the business, from the chair of the department that oversees the implementation of the curriculum to the tech worker on the ground who helps to implement VR/AI. Managers can design advanced leadership plans based on digital fluency, AI governance, and change management for mid-level directors who have something to contribute to making things better in their groups. They can also set roles like “digital learning coordinator” or “AI EdTech specialist” so there is are teams to help out faculty in tech and make sure it is implemented uniformly.

Thirdly, use data to lead. The digital and AI tool gives information to the leaders about decisions that they use based on the resources, for example, using the equipment downtime data to ask for extra maintenance money, or for faculties to train on, for example, using DLIS data to see what skills everyone misses out on. The managers can create a dashboard using numbers (like the DMST score, or how often folks use VR), and words (like stuff that came up when they talked to people, ideas from watching what was happening) - to see if doing digital /AI with normal life is working, and changing things based on the numbers and words. Like, if numbers show that VR training for staff fixes equipment problems, managers can copy it to other parts.

Fourth, build institutional resilience to cope with technological changes. The digital/AI technology is moving fast, agile, and forward-leaning leaders are needed. Managers have to develop flexible budgets in order to fund the development of new tech, form strategic relationships with EdTech vendors so they can get access to the latest technology, and establish innovation sandboxes which allow teachers to play around with new AI/VR apps without risking the main meal. Leadership also needs to give a clear picture of digital/AI change, they have to demonstrate how these technologies fit with the institution’s purpose (promoting access to practice, based learning, increasing students’ success), to get stakeholder support and handle push back against change.

Limitations and Future Directions

While the study was conducted within a single public university, sampling procedures, participant characteristics, and contextual constraints are limited, but will be clearly reported to support analytical rather than statistical generalization. Qualitative data analysis procedures, including coding stages, researcher triangulation, and inter-rater reliability checks, are explicitly described to enhance methodological transparency and trustworthiness (Biggs, 1993; Damsa & Muukkonen, 2020). It is true that the study gives important information about digital/AI leadership difficulties in higher education, but it is not completely devoid of limitations that point towards future research. One first it is about a study at one university and in a specific institution context (Public university in Thailand and focus on Decorative Materials Education) And maybe it can affect the researches generality Future studies need multi-site designs to show if digital/AI leadership problems are different at places like public versus private schools, where the govt pays versus where students pay for schooling, and from different cultures which would point out context specific blockers and moveable parts.

Second, the study focused mainly on short-term outcomes: an eight-week intervention was carried out, and no long-term sustainability under different leadership styles regarding digital /AI was studied. Future long-term studies will follow how leaders make different choices on things like resources and which faculty to train, and how to merge the new curricula with VR/AI through many semesters, with students' learning and the institution's abilities. It is as if it would light up when that 47% relativity improvement in DMST scores for the experimental group was lasting or lost over time, and how leadership copes with tech becoming outdated and teachers quitting.

Thirdly, focus on digital and AI leadership mainly from the perspective of teachers, students, and education leaders; do not include personnel such as technical personnel, curriculum personnel, school leaders, deans, and provosts. Further study should be a multi-stakeholder study on how leaders in each stakeholder group have different leadership roles and challenges, and how the collaboration between different stakeholder groups could better integrate digital/AI. Take a technician as an example, a technician will find some difficulty in making the equipment keep working and upgrading the program, institutional leaders may focus on a much bigger plan and allocating material.

Fourthly, this study mainly thought about VR as a technology context, so digital/AI leadership problems could be different for various EdTech resources (like AR, adaptive learning stuff, gen AI). Future research can compare the leadership challenges of each technology, find out if there are the same problems, for example, staff capacity shortness, and privacy. And tech-specific issues: AR needs mobile, and gen AI faces academic integrity risk problems. It would help us get a better sense of digital/AI leadership in higher education, and allow us to have some special plans for different tech spots.

And then lastly, there's the intersection of digital/AI leadership and equity and inclusion, which is another thing that's missing. More research should be done on whether or not the digital/AI leadership is helping to perpetuate or mitigate the inequality that already exists because of people having different levels of access to technology and different degrees of digital literacy. Plans for how we will create equitable digital change also need to be built up. Like leadership might select low-cost or open-source VR/AI tools to increase accessibility, or provide training for students without any previous digital experience. So that all of these students who are improved in digital and AI as well, not just the advantaged ones.

ACKNOWLEDGMENT

This research project was financially supported by Mahasarakham University.

REFERENCES

Abdellatif, R., & El-Wakeel, H. (2025). Assessing creative outcomes in studio-based learning: A comparative assessment of analytical rubrics. *International Journal of Design Creativity and Innovation*, *13*(1), 41-66.

Aktar, F., Maurer, F., & Ma, I. W. Y. (2025). *Evaluating virtual-reality training for effective pneumothorax management in thoracentesis* (Master's thesis, University of Calgary). University of Calgary.

AlGerafi, M. A., Zhou, Y., Oubibi, M., & Wijaya, T. T. (2023). Unlocking the potential: A comprehensive evaluation of augmented reality and virtual reality in education. *Electronics*, *12*(18), 3953.

Biggs, J. B. (1993). From theory to practice: A cognitive systems approach. *Higher Education Research and Development*, *12*(1), 73-85.

Damsa, C., & Muukkonen, H. (2020). Conceptualising pedagogical designs for learning through object-oriented collaboration in higher education. *Research Papers in Education*, *35*(1), 82-104.

Di Natale, A. F., Repetto, C., Riva, G., & Villani, D. (2020). Immersive virtual reality in K-12 and higher education: A 10-year systematic review of empirical research. *British Journal of Educational Technology*, *51*(6), 2006-2033.

Farouk, A. M., Naganathan, H., Rahman, R. A., & Kim, J. (2024). Exploring the economic viability of virtual reality in architectural, engineering, and construction education. *Buildings*, *14*(9), 2655.

Fitrianto, I., & Saif, A. (2024). The role of virtual reality in enhancing Experiential Learning: A comparative study of traditional and immersive learning environments. *International Journal of Post Axial: Futuristic Teaching and Learning*, 97-110.

Gulyamov, S. S., Egamberdiev, E., & Naeem, A. (2024). *Practice-oriented approach to reforming the traditional model of higher education with the application of EdTech technologies. In 2024 4th International Conference on Technology Enhanced Learning in Higher Education* (TELE) (pp. 340–343). IEEE. https://doi.org/10.1109/TELE62556.2024.10605684

Hamilton, D., McKechnie, J., Edgerton, E., & Wilson, C. (2021). Immersive virtual reality as a pedagogical tool in education: a systematic literature review of quantitative learning outcomes and experimental design. *Journal of Computers in Education*, *8*(1), 1-32.

Han, I., & Patterson, T. (2020). Teacher learning through technology-enhanced curriculum design using virtual reality. *Teachers College Record*, *122*(7), 1-34.

Ikromjon, R., & Rayhona, T. (2024). Development of a method to enhance the efficiency of establishing VR educational laboratories. *International Journal of Industrial Engineering, Technology & Operations Management*, *2*(2), 78-82.

Kolb, A. Y., & Kolb, D. A. (2006). Learning styles and learning spaces: A review of the multidisciplinary application of experiential learning theory in higher education. In R. R. Sims & S. J. Sims (Eds.), *Learning styles and learning: A key to meeting the accountability demands in education* (pp. 45–91). Nova Science Publishers.

Li, J., & Liang, W. (2024). Effectiveness of virtual laboratory in engineering education: A meta-analysis. *PloS one*, *19*(12), e0316269.

Marks, B., & Thomas, J. (2022). Adoption of virtual reality technology in higher education: An evaluation of five teaching semesters in a purpose-designed laboratory. *Education and Information Technologies*, *27*(1), 1287-1305.

Nortvig, A.-M., Petersen, A. K., Helsinghof, H., & Brænder, B. (2020). Digital expansions of physical learning spaces in practice-based subjects-blended learning in Art and Craft & Design in teacher education. *Computers & Education*, *159*, 104020.

Odell, M., Kennedy, T. J., Meyer, B., & Sarada, J. (2025). *The how and why of laboratory schools: Innovations and success stories in teacher preparation and student learning*. Stylus Publishing, LLC.

Poppe-Gale, K. (2025). Designing an Innovation Lab: A catalyst for entrepreneurial creativity and eperiential learning. *Developments in Business Simulation and Experiential Learning*, *52*.

Pramanik, S. (2024). Immersive innovations: Exploring the use of virtual and augmented reality in educational institutions. In *Developments and Future Trends in Transnational Higher Education Leadership* (pp. 229-243). IGI Global.

Samaniego, M., Usca, N., Salguero, J., & Quevedo, W. (2024). Creative thinking in art and design education: A systematic review. *Education Sciences*, *14*(2), 192.

Wu, M., Brill, D. A., Shirodkar, M. P., Tan, J., Poptani, M., Wang, Y., & Haworth, I. S. (2022). Using technology to automate syllabus construction for programmatic, curricular, faculty and experiential assessment activities. *International Journal of Educational Management*, *36*(1), 49-62.