QUBAHAN ACADEMIC JOURNAL
VOL. 6, NO. 3, July 2026
https://doi.org/10.48161/qaj.v6n3a2422

The Role of Augmented Reality and Virtual Reality in Enhancing Student Motivation and Performance: Evidence from Vocational Education in China Using Self-Determination Theory

Lixiang Zhang [1*] **and Padet Kakham** [1]

[1] Department of Education and Society, Institute of Science Innovation and Culture, Rajamangala University of Technology Krungthep, 10120 Bangkok, Thailand.

* **Corresponding author:** 679240200148@mail.rmutk.ac.th.

ABSTRACT: The integration of emerging technologies such as Augmented Reality (AR) and Virtual Reality (VR) has reshaped contemporary vocational education by offering immersive and interactive learning environments. This study investigates how AR/VR-based learning environments influence students' motivation and academic performance within vocational education settings in Guizhou, China, grounded in Self-Determination Theory (SDT). A quantitative research design was employed using purposive sampling, with data collected from 626 vocational students. Covariance-based Structural Equation Modeling (CB-SEM) was applied to test the proposed hypotheses. The results reveal that teachers' autonomy support and relatedness significantly enhance students' motivation, whereas perceived teacher competence does not exhibit a significant effect on motivation in AR/VR-assisted learning contexts. Furthermore, students' motivation is found to be a strong predictor of academic performance and acts as a mediating mechanism between SDT-related teaching factors and student performance outcomes. The findings extend SDT into the context of immersive learning technologies, demonstrating that AR and VR environments amplify the importance of socio-emotional dimensions of teaching over technical competence alone. This study provides practical implications for vocational educators, curriculum developers, and policymakers in optimizing teacher training, instructional design, and technology integration strategies to enhance student engagement and learning outcomes.

Keywords: Augmented reality (AR), Virtual reality (VR), Student motivation, Vocational education, Self-determination theory (SDT), Student performance.

I. INTRODUCTION

The advancement of education is fundamental, particularly in fostering common ground between university and vocational school environments [1, 2]. It requires the equitable distribution and ongoing enhancement of teacher resources across both sectors and also ensures that vocational instructors have equal opportunities and support to access educational resources [3, 4]. This study shows how important vocational teachers act as change agents, especially when it comes to improving learning by using new technologies like Augmented Reality (AR) and Virtual Reality (VR) as teaching tools [5, 6]. The adoption of AR and VR addresses unique challenges within vocational education, enhances teaching effectiveness, and contributes to broader educational reform. These technologies are particularly powerful for simulating real-world

scenarios, facilitating hands-on practice in safe environments, and bridging geographical barriers by providing high-quality instructional content accessible to teachers and students globally. Furthermore, AR and VR facilitate an interactive educational experience by integrating advancements in pedagogy and technology, resulting in enhanced learning outcomes [7, 8]. This technological transformation empowers teachers to personalize and adapt instruction based on individual student needs, enriches the utilization of educational resources, and fosters collaborative, engaging learning environments.

Training and workshops that provide teachers with hands-on experience, problem-solving abilities, and technical expertise are vital for strengthening students' skills and knowledge. AR enhances the learning environment by providing educators with access to a wide range of lesson plans, teaching aids, and educational resources [9, 10]. Similarly, VR fosters collaboration among teachers from different locations, allowing them to exchange resources, share experiences, and disseminate best practices, which collectively enhance the quality of instruction [11, 12]. These developments demonstrate that both AR and VR create meaningful opportunities for vocational teachers to elevate their professional performance and remain current with innovations in their fields [13, 14]. Furthermore, advancements in educational technology directly improve students' employability by equipping them with the credentials and competencies demanded in sectors such as information technology, engineering, healthcare, and the arts [15, 16]. Moreover, the integration of AR and VR enables teachers to assess and refine their instructional methods, thereby supporting the adoption of new educational theories and innovative teaching strategies that contribute directly to student success [17, 18].

Despite the presence of supportive national and local policies, practical measures to enhance vocational teachers' capabilities often remain inadequate, which poses serious obstacles to students' motivation and performance [19, 20]. This persistent lack of targeted support undermines efforts to close gaps in teacher motivation and effectiveness, which are critical for meaningful educational reform that integrates practical instruction. When vocational teachers are not equipped with well-developed instructional skills, their ability to implement and sustain innovative educational practices is compromised, ultimately impeding the broader advancement of vocational education. It becomes essential to investigate the potential of emerging technologies such as AR and VR in supporting both teaching and research within vocational education contexts. This raises important research questions, including: How does the implementation of AR/VR-supported practical training environments affect the motivation of vocational students in Guizhou? Furthermore, what is the relationship between students' motivational states and their perceived learning outcomes in AR/VR-integrated vocational training settings? Addressing these questions will offer helpful information about the role of innovative technologies in bridging existing gaps in teacher capacity and student achievement within vocational education.

This study aims to provide a robust scientific foundation and practical recommendations for enhancing the quality of vocational education. It will commence with a thorough assessment of current vocational education practices in China and globally, including an in-depth evaluation of teachers' competencies and instructional approaches. This study formulates targeted strategies focused on professional development, resource allocation, and the practical application of research outcomes with regard to identifying existing challenges and drawing insights from successful initiatives in other regions. Theoretically, the logic to explain how the teachers' skill with regard to SDT theory dimensions can lead to students' motivation and performance [21, 22]. Prior research has adopted SDT to illustrate that teacher and students' characteristics play a significant role in shaping the innovative learning [21–23]. Nevertheless, how teachers' improvisational behavior shapes students' motivation and performance is still an issue that has not been theoretically explained and empirically proven. Studies have shown that teachers' improvisational behavior is a trait that reflects the creativity and innovativeness to support learning process [24, 25]. Thus, it is worth exploring whether teachers who work with autonomy, competence and relatedness dimensions exhibiting students' improvisational motivation behaviors tend to adopt performance.

II. LITERATURE REVIEW

1. SELF-DETERMINATION THEORY (SDT)

Self-Determination Theory (SDT) underscores the pivotal roles of autonomy, competence, and relatedness in fostering student motivation, and these elements remain highly pertinent within technology-enhanced learning environments. Autonomy-supportive teaching, where educators provide students with choices and encourage independent learning, is anticipated to heighten motivation and engagement, as technology allows for the personalization and empowerment of individual learning experiences. When students feel they have control over their learning paths selecting topics, pacing, or resources they are more likely to invest effort and persist through challenges, resulting in enhanced performance and deeper learning. Similarly, competence-supportive teaching, marked by constructive feedback and suitably challenging tasks, is bolstered by technology's capacity to tailor activities to each student's skill level and deliver immediate feedback. Digital platforms can adapt content in real time to address individual learning gaps and strengths, reinforcing students' sense of efficacy and accomplishment. This ongoing feedback loop not only helps maintain students' motivation but also supports continuous improvement in their academic performance. Relatedness-supportive teaching, which nurtures positive and supportive relationships, can also be advanced through collaborative digital activities and effective teacher facilitation in virtual spaces [21–23].

Discussion forums, group projects, and peer review mechanisms foster a sense of community, ensuring that students feel connected and valued, even in remote or hybrid settings. When students perceive that they belong and are supported by both peers and instructors, their motivation and academic outcomes are further enhanced.

2. CORE CONCEPTS AND THEORETICAL FOUNDATIONS

Augmented Reality (AR) and Virtual Reality (VR) have fundamentally transformed the student learning process, shifting it from traditional methods to interactive, technology-rich experiences that enhance how students engage with digital content globally [6, 26]. These technologies enable students to interact simultaneously with both real and virtual environments. For instance, AR glasses enable learners to manipulate digital objects while maintaining awareness of their physical surroundings, thereby connecting digital innovation with real-world application [27]. This dual engagement makes learning more dynamic, immersive, and meaningful. Moreover, VR immerses students in fully virtual scenarios, providing opportunities to practice skills or conduct scientific experiments in a controlled, risk-free setting [28]. Teachers play a pivotal role in this transformation by designing new learning opportunities that utilize these technologies, such as skill-based simulations and real-time information delivery [29, 30]. AR and VR also make learning more accessible, inspiring students to explore fields and career paths they may not have previously considered. Teachers' encouragement, along with AR and VR, helps students work together and talk to each other [31]. Additionally, virtual field trips enable students to visit museums, cultural sites, or research centers that might otherwise be inaccessible. Overall, AR and VR offer powerful tools to enhance educational practices, providing immersive, hands-on experiences that improve understanding, retention, and student engagement in the learning process [17, 32].

3. HYPOTHESES DEVELOPMENT

Teachers' autonomy support demonstrates a significant and positive correlation with students' motivation, particularly intrinsic motivation [33, 34]. This support is crucial for cultivating a motivating classroom environment with regard to addressing students' basic psychological needs such as offering meaningful choices, listening to their perspectives, and providing clear rationales for tasks teachers foster greater interest, enjoyment, and engagement in learning. Moreover, autonomy support has been shown to enhance students' psychological well-being by reducing anxiety and promoting a positive, inclusive atmosphere. Research confirms that with strong autonomy support, students become more adept at self-regulating their learning and are more willing to participate actively in class, particularly when innovative technologies like AR and VR are incorporated into the learning process [21, 35]. Teachers' ability to tailor

instruction to accommodate different learning speeds and backgrounds further increases the relevance and practicality of lessons [22]. Additionally, when teachers themselves experience professional autonomy, they are more inclined to innovate and demonstrate greater commitment to student success, thereby fostering an environment that benefits both teachers and learners [23]. These findings underscore the fundamental role of autonomy support in promoting optimal student motivation and achieving positive educational outcomes.

- H1. Teachers' autonomy support has a positive effect on students' motivation.

Teachers' competence encompasses the ability to deliver effective instruction, manage classroom dynamics, and address the diverse needs of all students [11, 32]. When teachers perceive themselves as competent, they are more likely to exhibit sustained motivation and a desire for continuous professional development [24, 38]. Conversely, feelings of inefficacy or a lack of necessary skills can diminish motivation and hinder professional growth. Recent research highlights the significant role of augmented reality (AR) and virtual reality (VR) in enhancing learning outcomes by immersing students in real-world scenarios [7, 36]. These technologies bridge the gap between theoretical knowledge and practical application by situating learning within interactive virtual contexts. AR, in particular, enriches real environments with contextual digital information, enabling learners to grasp complex concepts by visualizing their application in authentic settings [23, 37]. This experiential approach fosters deeper understanding and skill acquisition, particularly in vocational education, where hands-on practice is crucial. Additionally, active engagement with AR and VR not only improves knowledge retention but also boosts learners' confidence as they practice skills in a safe and controlled environment [6]. Moreover, VR can facilitate remote learning, providing equitable access to high-quality educational experiences for geographically dispersed students. Thus, integrating AR and VR into educational practice supports both the development of teacher competence and the enhancement of student learning outcomes across various disciplines.

- H2. Teachers' competence support has a positive effect on students' motivation.

Relatedness refers to the fundamental need to establish meaningful connections with others, a need that is especially significant in educational environments [12, 29]. For teachers, feeling supported by colleagues, administrators, and students is crucial for sustaining motivation and overall well-being [39]. When educators perceive themselves as valued, respected, and supported in the workplace, they are more likely to experience reduced stress and foster stronger relationships with their students. Empirical studies have shown that teachers who feel deeply connected to their professional communities report higher levels of motivation and job satisfaction [14, 40]. Supportive school environments characterized by positive interactions, a strong sense of community, and collaborative cultures further enhance intrinsic motivation and contribute to teachers' well-being [18]. Schools can nurture relatedness by promoting respect, encouraging collaboration, and creating opportunities for teamwork among educators [17, 26]. When teachers experience a genuine sense of belonging, this not only positively influences their motivation but also enhances students' motivation to study. A strong sense of relatedness encourages teachers to invest more in their students' success, which is a critical factor in supporting student motivation and achievement.

- H3. Teachers' relatedness support has a positive effect on students' motivation.

Teachers who believe they can perform their jobs effectively are more likely to experience intrinsic motivation, as they feel empowered to achieve their professional goals and witness the positive outcomes of their efforts [41, 42]. This sense of efficacy is further reinforced when teachers observe tangible student progress, which in turn enhances their motivation and dedication to teaching [43, 44]. Consistent positive experiences and professional achievements serve as important sources of reinforcement, fostering greater confidence and a sustained commitment to professional growth [19, 38]. Moreover, the integration of advanced technologies such as AR and VR empowers teachers to design and deliver innovative, student-centered lessons that address diverse learning needs. This technological flexibility not only enhances instructional quality but also provides teachers with increased control over their teaching methods, further strengthening their sense of competence and autonomy. On the student side, the perception of autonomy being given meaningful choices and feeling valued significantly boosts motivation and engagement [13, 45].

For example, when students are allowed to select their own project topics or learning activities, they are more likely to invest effort and produce higher-quality work, leading to improved academic outcomes.

- H4. Students' motivation has a positive effect on learning performance.

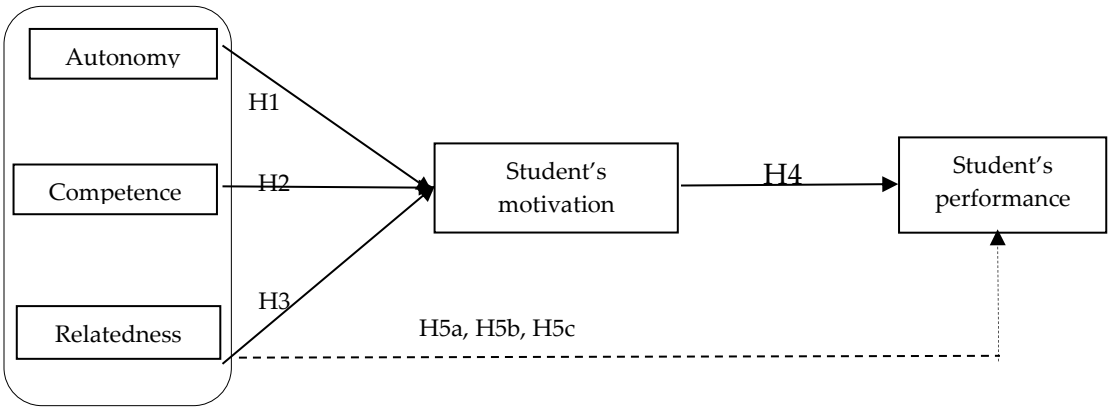

FIGURE 1. Research framework.

As illustrated research framework in Figure 1, teachers who perceive a high degree of control over their professional activities typically exhibit greater motivation, job satisfaction, and commitment to their work [24, 32]. Autonomy empowers teachers to take ownership of their instructional practices, enabling them to align teaching methods with their personal values and pedagogical philosophies. This fosters higher motivation and enhances adaptability, allowing teachers to better meet the diverse needs of their students. Conversely, when educators feel restricted by external mandates such as rigid curricula or excessive standardized testing, both student motivation and performance can be negatively affected [5, 37]. To support teacher autonomy, schools should foster collaborative environments that promote idea sharing, peer support, and provide both emotional and professional resources [34]. Furthermore, the motivation that arises from teachers' sense of relatedness feeling connected and valued by students and colleagues plays a critical role in shaping student outcomes [4, 39]. When teachers experience strong relational bonds in their professional community, they are more motivated and emotionally invested, which translates into more supportive and engaging learning environments. These positive teacher-student relationships significantly enhance students' own motivation, which in turn serves as a mediator that improves students' academic performance. It proves that teachers' relatedness motivation extends beyond teachers themselves and exert a considerable influence on student engagement, persistence, and achievement. Moreover, when teachers experience both autonomy and competence, along with a strong sense of relatedness, they are more enthusiastic and engaged, further contributing to a positive and productive educational environment and ultimately fostering better student learning outcomes.

- H5a. Students' motivation has a positive effect in mediating the relationship between teacher autonomy and students' learning performance.
- H5b. Students' motivation has a positive effect in mediating the relationship between teacher competence and students' learning performance.
- H5c. Students' motivation has a positive effect in mediating the relationship between teacher relatedness and students' learning performance.

III. METHODOLOGY

1. RESEARCH DESIGN

Thirty Guizhou vocational students, Ph.D. candidates, and professors were invited to verify the wording of the measurement items. The pretest and pilot test for this study consisted of five rounds of wording

revisions. The questionnaire includes demographic questions about gender, age, education, experience, and status, all of which serve as control variables. The study was carried out from July to September of 2024. Confirmatory Factor Analysis (CFA) and structural model analysis are the two key stages of the design. The teachers' autonomy, competence and relatedness in AR and VR are adopted from [28]. The students' motivation refers to [22]. Furthermore, students' performance refers to [24]. Figure 2 shows the research process.

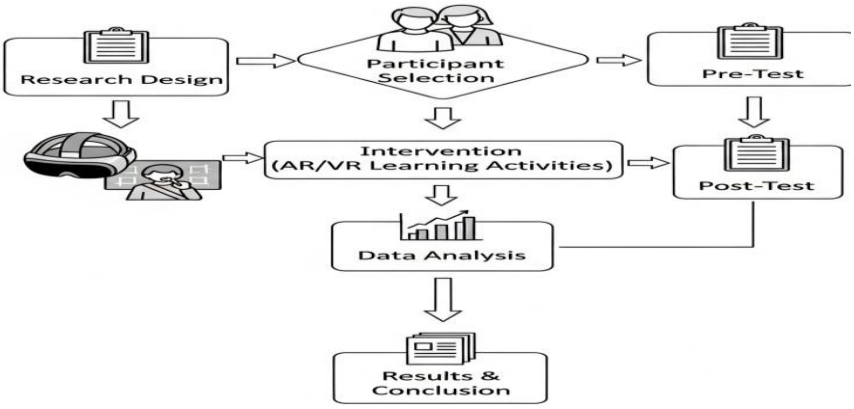

FIGURE 2. Research method diagram.

2. TARGET POPULATION AND SAMPLING

Figure 3 shows AR and VR illustrations during the learning process [46]. This study employs an online survey platform and Chinese social media channels such as Weibo and Line to engage a broader audience among vocational students in Guizhou province, China. This has led to significant changes in the appearance and structure of both regular schools and vocational schools. The results will help the education sector come up with plans that balance social and economic growth.

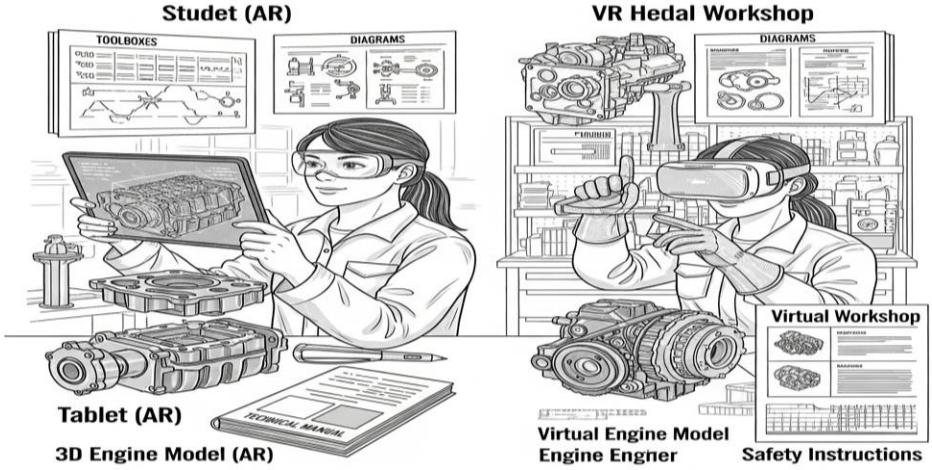

FIGURE 3. AR and VR media illustration used.

3. DATA COLLECTION METHODS

A purposive sampling method will be employed to ensure a representative and distinctive sample of the research population. The participants also must have direct experience as students utilizing AR and VR

technologies. The students also agree to participate by giving their full consent. This study will undergo two essential evaluation phases: a pre-test and a pilot test to improve the reliability and validity of the research instrument. The anonymity of participants will be preserved, and any sensitive information will be securely handled to ensure privacy [47]. This research employs a two-step methodology for Structural Equation Modelling (SEM). This study applies SPSS and AMOS statistical software to examine the correlation coefficient matrix of constructs. Furthermore, the convergent validity of each construct is higher than the standard recommended, as well as the values of reliability of each construct, all higher than the standard [46].

All participants provided informed consent prior to enrollment in the study. Written informed consent was obtained from all individuals included in the research. The study protocol was reviewed and approved by the Ethics Committee of Mahachulalongkornrajavidyalaya University on May 1st, 2024 and number R 771 / 2024. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. All participants provided informed consent after explaining the study purpose and assuring confidentiality.

IV. RESULTS

1. SAMPLE STRUCTURE AND DESCRIPTIVE STATISTICS

Table 1 shows the demographic profile of the respondents, including gender, age, and experience using AR and VR technologies. The sample consists of 325 males (51.9%) and 301 females (48.1%), reflecting a relatively balanced distribution. A total of 189 respondents (30.2%) are the first-year students, 259 (41.4%) are the second-level students, and 209 (33.3%) are the third-level students. A total of 185 teachers and students have more than 3 years of experience (29.6%); 168 have 1 year of experience; and 167 are 2-year applicants who apply the AR and VR approaches during the learning process.

Table 1. Sample structure.

Demographics	Frequency	Percentage (%)	Accumulated Percentage (%)
Gender			
Male	325	51.9	51.9
Female	301	48.1	100.0
Students' Level			
Level 1 (1st year)	188	30.0	30.0
Level 2 (2nd year)	227	36.3	66.3
Level 3 (3rd year)	211	33.7	100.0
Experience using AR and VR			
1 year	198	31.1	31.1
2 years	197	31.0	62.1
3 years	241	37.9	100.0

The results present the mean, standard deviation, and correlation coefficients among five key variables (See Table 2). Autonomy support shows a mean of 5.35 and a standard deviation of 0.981, with a reliability of 0.771, competence support, and relatedness support, which have mean of 5.16 and 5.27, and standard deviation of 0.940 and 1.245, respectively. Students' motivation has a mean of 5.11, a standard deviation of

0.980, and strong correlations with students' performance with the standard deviation value 4.55 and mean 1.290.

Table 2. Pearson correlation.

Constructs	Mean	SD	AS	CS	RS	SM	SP
AS	5.35	0.981	0.771				
CS	5.16	0.940	0.209**	0.756			
RS	5.27	1.245	0.433**	0.304**	0.857		
SM	5.11	0.980	0.522**	0.411**	0.544**	0.788	
SP	4.55	1.290	0.357**	0.232**	0.732**	0.581**	0.811

Diagonal elements are the square roots of the AVE for each construct
Pearson correlations are shown below the diagonal
Significant at *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$

2. *RELIABILITY AND VALIDITY ANALYSIS*

The initial phase entails the examination of the measurement model, during which convergent validity and reliability are evaluated by confirmatory factor analysis (CFA) and Cronbach's Alpha (α). Convergent validity ascertains that the measurement items accurately embody their corresponding constructs, whereas reliability assesses the internal consistency of the measurement scales. The reliability and validity analyses are carried out in this part. Confirmatory factor analysis is used to examine validity, and Cronbach's Alpha (α) and SMC are used to assess the items' and constructions' reliability. The convergent validity is assessed by measuring the Composite Reliability (CR) and Average Variance Extracted (AVE) of each concept. Composite reliability (CR) is used to assess each construct's internal consistency. The average proportion of variation explained by a collection of measurement items of a latent construct is also reflected in the value of average variance extracted (see Table 3).

Table 3. Measurement result.

Item	MLE Parameter Estimation		SMC	CR	AVE	α
	Item Loading	Measurement Error (δ/ε)				
Autonomy Support (AS)				0.935	0.672	0.884
1. Teachers help me to seek ideas during learning using AR and VR.	0.864	0.431	0.569			
2. Teachers provide meaningful options in learning activities using AR and VR.	0.825	0.360	0.640			
3. Teachers contribute to a positive value during the learning process using AR and VR.	0.757	0.458	0.542			
4. The teacher has a good skill to support my learning process using AR and VR.	0.725	0.492	0.508			
5. The teacher helped me to learn skills using AR and VR.	0.872	0.220	0.780			
Competence Support (CS)				0.863	0.752	0.839
1. Teachers explain concepts more clearly and easier using AR and VR.	0.794	0.246	0.732			

2. Teachers allow me to express my ideas using AR and VR.	0.862	0.249	0.751			
3. Teachers give me the freedom to explore topics and activities using AR and VR.	0.878	0.358	0.642			
4. Teachers provide feedback during the learning process using AR and VR.	0.795	0.407	0.593			
5. Teachers enhance my skill using AR and VR.	0.799	0.973	0.627			
Relatedness Support (RS)				0.866	0.733	0.857
1. The teacher helped me using AR and VR.	0.812	0.299	0.701			
2. Teachers care about my progress using AR and VR.	0.763	0.284	0.716			
3. Teachers applied respect in the classroom environment using AR and VR.	0.841	0.345	0.655			
4. The teacher helps me feel comfortable using AR and VR.	0.828	0.413	0.757			
5. Teachers have the capacity to compete in the course using AR and VR.	0.843	0.578	0.368			
6. The teacher informed me about the benefits of using AR and VR.	0.822	0.202	0.737			
Students' motivation (TM)				0.874	0.667	0.869
1. I consider using AR and VR during the learning process.	0.765	0.248	0.752			
2. I want to start my own skill and knowledge to realize my idea.	0.866	0.260	0.740			
3. I want to start a study to be a successful person	0.741	0.159	0.841			
4. I want to start to learn so that I can help others.	0.801					
5. I want to serve social problems through teaching and AR/VR tools.	0.764	0.360	0.640			
6. I want to make people's lives better through teaching and learning.	0.749	0.337	0.663			
Students' performance (SP)				0.843	0.733	0.867
1. I am able to convey ideas and information clearly to colleagues.	0.776	0.258	0.742			
2. I am able to work with a team to achieve a common goal	0.851	0.349	0.631			
3. I was able to identify problems quickly and find innovative solutions	0.742	0.255	0.755			
4. I am able to manage my time well to complete tasks on time.	0.855	0.341	0.659			
5. I believe it is socially expected to support my community.	0.687	0.521	0.479			
6. I am able to use technological tools that are relevant to learning process.	0.841	0.434	0.566			

Note. Model fit: $\chi^2/df = 3.632$, GFI = 0.927, NFI = 0.931, CFI = 0.935, IFI = 0.931, and RMSEA = 0.047.

3. STRUCTURAL MODEL RESULTS

Table 4 shows that the hypothesis testing results offer clues about the relationships between autonomy support and students' motivation in the learning process, AR and VR as tools, and other relevant constructs. The empirical findings prove that teachers' autonomy support has a positive effect on students' motivation (γ11=0.174, $p < 0.01$) to support H1. However, teachers' competence does not positively affect students' motivation (γ12=0.075, $p > 0.05$), indicating that H2 is unsupported. Furthermore, teachers' relatedness motivation significantly enhances students' motivation (γ13=0.269, $p < 0.01$) to support H3. It means that teachers' motivation is a crucial factor in enhancing students' motivation. Students' motivation plays an important role in influencing students' performance, particularly in vocational areas (β21=0.270, $p < 0.001$) to support H4. In addition, students' motivation is the key factor that determines whether teachers' skills in AR and VR in vocational areas actively participate in learning activities.

Table 4. Structural model result.

Hypotheses				Paths	Coefficients	Result
H1	AS	→	SM	γ_{11}	0.174**	Supported
H2	CS	→	SM	γ_{12}	0.075	Unsupported
H3	RS	→	SM	γ_{13}	0.269**	Supported
H4	SM	→	SP	β_{21}	0.270***	Supported

Note: *$p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

4. MEDIATION RESULTS

This study adopted a confidence interval bootstrapping method with 5000 simulations to test how students' motivation mediates the relationship between teachers' motivation support and students' performance (See Table 5). Bootstrapping is a nonparametric statistical process in which the dataset is repeatedly sampled [48]. The Teachers' autonomy support positively influenced students' performance was mediated by motivation (β = 0.174 x 0.270 = 0.046, CI= (0.021, 0.075)) to support H5a. Furthermore, the teachers' competence and relatedness positively influenced students' performance was mediated by motivation (β = 0.075 x 0.270 = 0.020, CI= (0.017, 0.035)); (β = 0.269 x 0.270 = 0.072, CI= (0.047, 0.085)) to support H5b and H5c. Motivation teachers to conduct research, enhance their pedagogical methods, and promote progress in the field of education. Empirical evidence demonstrates a strong and positive correlation between students' motivation and students' performance. Competency support significantly influences teachers' motivation and, consequently, their research performance. Teachers feel more equipped to undertake research when they have access to academic resources, adequate training, and institutional support. The substantial indirect effect of teachers' autonomy, competence and relatedness support on students' performance towards motivation indicates the necessity to enhance teachers' resources to improve their scholarly contributions. In addition, a sense of belonging and professional collaboration among teachers is essential for enhancing students' motivation and performance. It means that teachers' motivation can be significantly increased by fostering a culture of continuous professional development where they receive constructive criticism and planned opportunities for advancement.

Table 5. Mediation result.

Indirect effect				B	SE	95% CI
Autonomy	→	Students' motivation	→ Student performance	0.046	0.055	(0.021, 0.075)
Competence	→	Students' motivation	→ Student performance	0.020	0.046	(0.017, 0.035)
Relatedness	→	Students' motivation	→ Student performance	0.072	0.037	(0.047, 0.085)

Note: Significant at *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$.

V. KEY FINDING

1. DISCUSSION

The effect size of teachers' autonomy support on students' motivation in vocational schools is indicating a strong and meaningful effect on the learning process. This finding is consistent with previous research, which found that autonomy support positively affects students' motivation in various educational settings, including vocational contexts [2, 8, 35, 40]. The strength effect of the autonomy dimension can be attributed to several factors. Vocational education, well-structured academic support systems, and reinforcing institutional practices that strengthen the benefits of autonomy-supportive teaching approaches. Furthermore, the integration of innovative instructional strategies, particularly the use of advanced technologies such as Augmented Reality (AR) and Virtual Reality (VR), further enhances the impact of autonomy support. These technologies enable student-centered learning models that offer personalized learning pathways, authentic hands-on experiences, immediate feedback, and collaborative virtual environments, all of which are conducive to fostering greater autonomy and motivation among students.

Teachers' competence support is widely recognized as a key element in enhancing students' motivation and learning outcomes, the present study found that competence support did not have a significant effect on students' motivation, particularly within the context of Augmented Reality (AR) and Virtual Reality (VR) integration in vocational education. Several factors may account for this non-significant result. First, motivation is a multifaceted construct that is influenced by a combination of personal, technological, and contextual factors. In this study, external challenges such as insufficient resources, limited funding, and professional isolation [26, 49] may have mitigated the potential benefits of competence support. Similarly, a lack of ongoing professional development and collaboration opportunities for teachers may hinder their ability to effectively implement competence-supportive strategies in technologically advanced settings. Additionally, the novelty of AR and VR technologies in educational contexts may introduce a learning curve for both teachers and students, potentially limiting the immediate impact of competence support. The findings suggest that competence support alone is not sufficient to drive motivation unless it is delivered within a broader, context-sensitive framework that ensures equitable access to technology, comprehensive teacher training, and collaborative learning opportunities. Therefore, embedding competence support within a supportive technological and institutional ecosystem is essential to harness its full motivational potential in vocational education.

Although teachers' relatedness support has a positive and significant effect on students' motivation, they frequently lack adequate time, training, and financial resources to engage in meaningful academic activities, which subsequently influences students' performance [3, 32]. The divergence between current findings and prior research underscores the necessity of contextualizing relatedness support within specific educational and teachers' professional settings [43]. It also demonstrates that relatedness support alone is insufficient to enhance students' learning motivation without substantial institutional and social support frameworks [24, 39]. Similarly, some developing regions, such as India and Sub-Saharan Africa, indicate that relatedness support is not enough to strengthen student motivation without strong institutional and social support [15, 19]. Therefore, the interplay between autonomy support and broader environmental elements is essential when assessing the effectiveness of motivation-enhancing strategies for both teachers and students in vocational contexts.

These results confirm that students' motivation significantly influences their performance, especially within vocational education, where the integration of AR and VR technologies is key. In addition, when students are highly motivated, they are more likely to engage fully with interactive and immersive learning experiences, leading to substantial improvements in both skill acquisition and academic achievement. The use of AR and VR not only facilitates greater access to resources and training opportunities but also supports differentiated instruction, thereby improving teaching effectiveness and promoting equity in educational outcomes. Moreover, the equitable distribution of qualified teachers, who are proficient in utilizing AR and

VR technologies, ensures that students receive consistent guidance and support [13, 45, 50]. This professional competence among teachers not only enhances the quality of instruction but also reinforces students' motivation and confidence, further driving their academic performance. The findings also highlight that ongoing teacher training and equal access to digital resources are crucial for maintaining high levels of student motivation and achievement. It proves that student motivation is a critical determinant of educational success, particularly when supported by innovative technologies and robust instructional strategies. Combining AR/VR tools with tailored teaching approaches and comprehensive support frameworks creates an inclusive, effective learning environment.

Student motivation serves as a crucial mediating variable in the relationship between teachers' autonomy, competence, and relatedness support to promote students' performance [24, 25]. According to Self-Determination Theory (SDT), when teachers create learning environments that satisfy students' basic psychological needs for autonomy, competence, and relatedness, they foster higher levels of intrinsic motivation [21–23]. This aligns to preliminary studies which found that autonomy support from teachers empowers students by providing meaningful choices, encouraging independent learning, and respecting students' perspectives. When students perceive a sense of control over their learning, their intrinsic motivation increases, leading to greater engagement and effort in academic tasks. This heightened motivation translates into more effective learning and improved performance, as students take ownership of their educational experiences. Similarly, competence support involves providing constructive feedback, setting appropriately challenging tasks, and recognizing students' achievements. When students feel capable and confident in their abilities, their motivation to learn and succeed is strengthened. Motivated students are more likely to seek out opportunities for growth, utilize feedback to improve, and demonstrate higher levels of achievement. Relatedness support plays an important role to influencing students' performance when students feel connected and valued within their learning community. This sense of belonging encourages collaborative participation, sustained effort, and resilience, all of which contribute to enhanced performance. In technology-enhanced environments, such as those incorporating AR and VR, the mediating effect of motivation becomes even more pronounced. Teachers' support in these dimensions can leverage digital tools to personalize learning, provide immediate feedback, and foster collaborative virtual spaces, all of which heighten student motivation.

2. THEORETICAL CONTRIBUTIONS

The identification of three universal psychological needs autonomy, competence, and relatedness serve as a cornerstone of Self-Determination Theory (SDT) [21, 22]. These needs are essential for personal growth, motivation, and overall well-being. When these psychological needs are not met, individuals may experience diminished motivation and lower well-being; conversely, satisfying these needs is fundamental to fostering motivation. Understanding and supporting these needs is particularly important in vocational education, where the integration of technologies such as Augmented Reality (AR) and Virtual Reality (VR) can further enhance the educational experience for both teachers and students. AR and VR facilitate personalized and adaptive learning environments, making it possible to support autonomy by allowing learners to make choices and engage in self-directed activities. This study also extends the SDT concept with regard to describes three orientations students may develop: impersonal, controlled, and autonomous. Students with a good orientation are more influenced by external demands and rewards, while those with an autonomous orientation act based on personal interests and values. Teachers can significantly increase student engagement, motivation, and, ultimately, learning outcomes in vocational contexts towards addressing these psychological needs and utilizing technology to create supportive learning environments.

3. PRACTICAL IMPLICATIONS

The findings offer education policymakers a robust scientific basis for designing more targeted teacher development policies and programs that integrate AR and VR technologies. The stakeholders can identify essential technological and pedagogical skills towards evaluating the current performance and needs of vocational teachers, as well as gaps in resources and competencies among both teachers and students. This assessment enables the creation of training initiatives and policies specifically focused on improving AR and

VR integration in vocational education. The results highlight the importance of equipping education stakeholders with the necessary tools and expertise to implement these technologies effectively in their instructional practices. Furthermore, the findings underscore the need for professional development programs that enhance teachers' research abilities and emphasize technological advancement. This research provides a fresh perspective and a solid foundation for future educational studies, particularly within vocational contexts. Consequently, it is crucial for government and university leaders to take proactive steps in supporting practical teaching approaches that incorporate advanced technologies. Developing teachers' skills in scenario-based training is especially important for improving students' ability to apply AR and VR, ultimately leading to more effective learning experiences and an elevated overall quality of education.

VI. CONCLUSION

The primary aim of this study is to promote educational equity by ensuring that all students, regardless of their geographic location, have access to high-quality education. Contextual barriers significantly limit the effectiveness of autonomy support, which serves as a foundational factor in motivating vocational teachers and students. Although autonomy plays an important role in enhancing student motivation, this research demonstrates that autonomy alone is insufficient to foster meaningful academic engagement especially in settings where institutional resources, mentorship, and professional recognition are lacking. The findings indicate that the influence of autonomy support on motivation is indirect and limited, especially when incorporating advanced technologies like AR and VR. This underscores the necessity for broader systemic support. Comparative evidence from both developed and developing regions indicates that autonomy support must be complemented by comprehensive institutional and social frameworks to achieve meaningful results. The development of collaborative learning communities, access to mentorship opportunities, and equitable resource distribution should be the primary priorities of effective policies. Furthermore, while the integration of technologies development such as AR and VR promises for enhancing educational practice, the true potential can be realized if teachers receive sustained training, support, and professional development. This comprehensive approach advances the teachers professional, and students' motivation and learning outcomes.

This study was employed in Guizhou province; hence, the result does not represent China as a whole. Future studies should investigate the study framework in other educational contexts in China and globally. Comparative research across various schools and nations can provide insights into the impact of cultural, economic, and regulatory disparities on these interactions. Furthermore, examining various educational and teaching environments is needed to obtain comprehensive knowledge of the motivations and performance of both teachers and students. The participants filled out the questionnaires as situational factors and self-reports. A future study needs to investigate internal (such as, psychology and students' personal experiences) and external factors, such as the learning environment and government support, from the perspective of education. Future study also needs to apply a longitudinal study to investigate the effects of alterations in governmental policies and educational environments on teachers' and students' behaviors. Future study also should incorporate external mediating and moderating elements, including government policies, economic recessions, or sustainability rules, to elucidate technology development on teacher and student performance.

Funding Statement

This research received no external funding.

Author Contributions

Conceptualization, L. Z. and P. K.; methodology, L. Z. and P. K.; data curation, L. Z.; formal analysis, L. Z.; investigation, L. Z.; project administration, L. Z.; supervision, P. K.; validation, P. K.; visualization, L. Z.; writing—original draft preparation, L. Z.; writing—review and editing, P. K. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data are available from the authors upon request.

Acknowledgments

Not applicable.

REFERENCES

1. Olbina, S., & Glick, S. (**2022**). Using integrated hands-on and VR/AR approaches in construction management education. *International Journal of Construction Education and Research, 19*(3), 341–360.
2. Que, Y., & Hu, X. (**2025**). Background music for studying in VR learning environments. *Interactive Learning Environments, 33*(9), 5516–5529.
3. Adeyemi, I. O., Sulaiman, K. A., Abdulsalam, Z. M., & Issa, A. O. (**2023**). Virtual and augmented reality as predictors of users' intention to use Lagos State Public Library, Lagos State, Nigeria. *The Electronic Library, 41*(5), 682–699.
4. Hafizi, N. (**2025**). Enhancements in design education by integrating advanced learning technologies (AR/VR) in architectural schools. *Open House International, 50*(3), 543–559.
5. Saprudin, S., Lutfi, S., Hamid, F., Ismail, A., Hayat, M. S., & Gumilar, S. (**2025**). Augmented reality in the unbounded research science laboratories: Improving college students' science competencies. *Qubahan Academic Journal, 5*(1), 798–809.
6. Zhao, X., Ren, Y., & Cheah, K. S. L. (**2023**). VR/AR in education: Bibliometric analysis. *SAGE Open, 13*(3).
7. Sakr, A., & Abdullah, T. (**2024**). Virtual and augmented reality and learning analytics: A systematic review. *Education and Information Technologies, 29*, 19913–19962.
8. Shukla, V., Rana, S., & Prashar, S. (**2024**). Virtual and augmented reality in tourism experiences. *The Bottom Line*.
9. Alam, A., & Mohanty, A. (**2023**). Educational technology: Exploring the convergence of technology and pedagogy through mobility, interactivity, AI, and learning tools. *Cogent Engineering, 10*(2).
10. Rodriguez-Saavedra, M. O., et al. (**2025**). Augmented reality as an educational tool. *Information, 16*(5), 372.
11. Blankendaal-Tran, K. N., Meulenbroeks, R. F., & van Joolingen, W. R. (**2026**). Teachers' and students' need for supporting digital research skills in secondary STEM education. *European Journal of STEM Education, 11*(1), 1–17.
12. Geriş, A., Çukurbaşi, B., Tunga, Y., & Engin, G. (**2025**). From users to creators: Design and evaluation of a VR professional development program for educators. *Computers & Education, 243*, 105518.
13. Liu, Y., Zhan, Q., & Zhao, W. (**2023**). A systematic review of VR/AR applications in vocational education. *Interactive Learning Environments, 32*(10), 6375–6392.
14. Weijzen, S. M. G., Onck, C., Wals, A. E., Tassone, V. C., & Kuijer-Siebelink, W. (**2023**). Vocational education for sustainability. *Journal of Vocational Education & Training, 76*(2), 331–353.
15. Hao, T., Wang, W., Wang, G., Yang, W., & Ma, K. (**2025**). From "chosen ones" to "leftovers": A historical analysis of China's vocational education and training system, 1949–2023. *Education + Training, 67*(3), 436–456.
16. Shamad, M. I., Sari, H., Suti, M., Junaidi, J., & Nurjannah, N. (**2023**). Trust and learning performance during COVID-19. *Knowledge Management & E-Learning, 15*(2), 303–321.
17. Javaid, M., Haleem, A., Singh, R. P., & Dhall, S. (**2024**). Role of virtual reality in advancing education with sustainability and identification of additive manufacturing as its cost-effective enabler. *Sustainable Futures, 8*, 100324.
18. Long, Y., Zhang, X., & Zeng, X. (**2025**). Application and effect analysis of virtual reality technology in vocational education practical training. *Education and Information Technologies, 30*, 9755–9786.
19. Darling-Hammond, L., Flook, L., Cook-Harvey, C., Barron, B., & Osher, D. (**2019**). Implications for educational practice of the science of learning and development. *Applied Developmental Science, 24*(2), 97–140.
20. Zuo, H., Zhang, M., & Huang, W. (**2025**). Lifelong learning in vocational education. *Journal of Innovation & Knowledge, 10*(3), 100694.
21. Reeve, J., & Cheon, S. H. (**2021**). Autonomy-supportive teaching: Benefits and applications. *Educational Psychologist, 56*(1), 54–77.
22. Wong, Z. Y., Tan, S. H., Liem, G. A. D., Chan, M., Liu, W. C., Poon, K. K., Kang, T., & Ng, S. C. (**2025**). Autonomy support and academic motivation. *Educational Psychology, 45*(8), 863–885.
23. Wang, C. K. J., Reeve, J., Liu, W. C., Kee, Y. H., Ng, B., Chua, L. L., & Kong, L. C. (**2025**). Autonomy-supportive intervention for STEM teachers. *Heliyon, 11*(3), e42150.
24. Hanaysha, J. R., Shriedeh, F. B., & In'airat, M. (**2023**). Impact of classroom environment, teacher competency, ICT resources, and university facilities on student engagement and academic performance. *International Journal of Information Management Data Insights, 3*(2), 100188.

25. Yang, J., Liu, Y., Arifani, Y., & Junaidi, J. (**2024**). Entrepreneurial education and student motivation. *International Journal of Learning, Teaching and Educational Research, 23*(11), 268–286.
26. Ngo, T. T. A., Tran, T. T., An, G. K., & Nguyen, P. T. (**2025**). Investigating AR marketing application on consumer purchase intentions. *Computers in Human Behavior Reports, 18*, 100648.
27. Rohayati, Y., & Abdillah, A. (**2024**). Digital transformation for Society 5.0. *Societies, 14*(12), 266.
28. Crogman, H. T., Cano, V. D., Pacheco, E., Sonawane, R. B., & Boroon, R. (**2025**). Virtual reality, augmented reality, and mixed reality in experiential learning: Transforming educational paradigms. *Education Sciences, 15*(3), 303.
29. Ironsi, C. S. (**2023**). Investigating the use of virtual reality to improve speaking skills: Insights from students and teachers. *Smart Learning Environments, 10*, 53.
30. Koumpouros, Y. (**2024**). Revealing the true potential and prospects of augmented reality in education. *Smart Learning Environments, 11*, 2.
31. Serrano-Ausejo, E., & Mårell-Olsson, E. (**2024**). Immersive technologies and 21st-century skills. *Education and Information Technologies, 29*, 5571–5597.
32. Dechsling, A., Vister, O. M., Johansen, T. E., Børtveit, L., Herikstad, Y., & Nordahl-Hansen, A. (**2024**). Implementing virtual reality in special education: Teachers' perspectives. *International Journal of Disability, Development and Education, 1–16*.
33. Nguyen, D., See, B. H., Brown, C., & Kokotsaki, D. (**2026**). Leadership for teacher retention: Supporting autonomy, development, and voice. *Oxford Review of Education, 52*(1), 96–116.
34. Uslukaya, A., & Zincirli, M. (**2025**). Teacher resources and work engagement. *Social Psychology of Education, 28*, 127.
35. Deniz, F. K., Spies, T. G., Higgins, K., Brown, M. R., & Boone, R. (**2024**). Autonomy supportive teaching behaviors: Perceptions of teachers in special, general, gifted, and bilingual education settings. *Action in Teacher Education, 1–15*.
36. Al-Ansi, A. M., Jaboob, M., Garad, A., & Al-Ansi, A. (**2023**). Analyzing augmented reality (AR) and virtual reality (VR) recent development in education. *Social Sciences & Humanities Open, 8*(1), 100532.
37. Salehi, N. (**2025**). Teaching vocabulary with augmented reality. *Discover Education, 4*, 230.
38. Eryilmaz, N., Kennedy, A. I., Strietholt, R., & Johansson, S. (**2025**). Teacher job satisfaction: International evidence on the role of school working conditions and teacher characteristics. *Studies in Educational Evaluation, 86*, 101474.
39. Ulmanen, S., Tikkanen, L., & Pyhältö, K. (**2024**). Peer support and life satisfaction. *European Journal of Psychology of Education, 39*, 2603–2617.
40. Bailey, W., Lavender, K., Youde, A., & Jiao, J. (**2024**). Experiences from great vocational education policy change in China—a teacher perspective. *International Journal of Training Research, 22*(1), 87–104.
41. Idkhan, A. M., Baharuddin, F. R., Aminuddin, A., Hidayat, A., Setialaksana, W., & Amiruddin, A. (**2025**). Bridging virtual learning and workforce readiness: The mediating role of virtual experience in vocational education. *Higher Education, Skills and Work-based Learning, 15*(6), 1282–1301.
42. Li, Y., Ying, S., Chen, Q., & Guan, J. (**2022**). An experiential learning-based virtual reality approach to foster students' vocabulary acquisition and engagement. *Sustainability, 14*(22), 15359.
43. Cha, W., Anderman, E. M., & Kim, M. (**2025**). How to promote intrinsically versus extrinsically motivated teachers' job satisfaction: Exploring individual and school factors. *Teaching and Teacher Education, 166*, 105179.
44. Okunlola, J. O., & Naicker, S. R. (**2025**). Deconstructing leadership in the post-industrial era. *European Journal of STEM Education, 10*(1), 26.
45. Jiang, H., Zhu, D., Chugh, R., & Jin, W. (**2025**). Virtual reality and augmented reality-supported K-12 STEM learning: Trends, advantages and challenges. *Education and Information Technologies*.
46. Hair Jr, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (**2019**). *Multivariate data analysis* (8th ed.). Cengage Learning.
47. Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (**2003**). Common method biases in behavioral research. *Journal of Applied Psychology, 88*(5), 879–903.
48. Hayes, A. F. (**2018**). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (2nd ed.). Guilford Press.
49. Ling, Y., Chung, S. J., & Wang, L. (**2023**). Research on reform of management system of higher vocational education in China. *Current Psychology, 42*, 1225–1237.
50. Mansour, N., Aras, C., Staarman, J. K., & Alotaibi, S. B. M. (**2025**). Embodied learning of science concepts through augmented reality technology. *Education and Information Technologies, 30*, 8245–8275.