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The Effect of Teaching Portfolio using Virtual Reality Adoption on academic performance in China Universities

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Abstract

This study aims to understand how these VR Adoption enhanced teaching portfolios influence the academic performance of college students. The study sample included 10 universities which has VR courses and 539 students join in this study. SPSS and PLS were used to assess how the predictor variable VR mediated the degree to which teaching portfolio and academic performance. A total of 7 hypotheses are valid. The results confirm that VR plays a positive mediating role in teaching portfolios and academic performance.

Keywords: *Virtual Reality; Teaching Portfolios; Academic Performance; Mediating Effect; VR Adoption.*

1. Introduction

Virtual reality technology is currently one of the most development space and application value of technology in the field of education, in promoting education and teaching reform has great potential, virtual reality technology is highly valued by the majority of scholars and attention, the reason for this is because of its own advantages (Smith & Brown, 2018). On the one hand, virtual reality technology has the imagination, immersion, interactivity and other characteristics, it can provide learners with nearly real learning environment Yang (Wang & Che, 2020), enhance the interactivity between students and the learning situation, conducive to the realization of meaningful learning. On the other hand, virtual reality technology can break the boundaries of the learning scene (Smith & Brown, 2018). Thus learners can experience a more shocking scene, and promote the enhancement of learning effects on the basis of improving learning motivation.

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1.1 Problem Statement

The value of VR adoption in education is also an urgent problem to be solved in the application of virtual reality technology in the field of education. First, the existing VR resources are mainly games and experiences, and there are fewer teaching resources for learners to learn. Secondly, because information in the virtual reality environment is presented dynamically, with short duration and more irrelevant information, learners must spend limited cognitive resources to search for key information, which further increases the cognitive load of learners and affects the learning effect. Finally, compared with traditional teaching methods, VR as an emerging technology into the process of teaching and using, its own novelty will strongly attract the attention of the learners, resulting in their attention to the content of the teaching is reduced, leading to unsatisfactory learning results. Therefore, how to use virtual reality technology to effectively improve the quality of education has become the focus of many scholars.

1.2 Research Objective and Research Question

This study is to solve the dilemma of virtual reality technology in education and teaching as a starting point, to explore the virtual reality technology as a mediator variable in the teaching file, to observe the impact on academic performance. Specific research objectives include. (1) To examine the relationship between teaching portfolio and academic performance in China university. (2) To determine the relationship between the teaching portfolio and VR in China university. (3) To identify the relationship between VR and academic performance in China university. (4) To examine the mediating effect of VR on the relationship between teaching portfolio and academic performance in China university.

The development of the research questions (RQ) in this paper is a crucial step in defining the scope and focus of the research.

Research Question 1: What is the relationship between teaching portfolio and academic performance in China university?

Research Question 2: What is the relationship between teaching portfolio and VR in China university?

Research Question 3: What is the relationship between VR and academic performance in China university?

Research Question 4: What is the mediating effect of VR on the relationships between teaching portfolio and academic performance in China university?

1.3 Hypothesis development and Hypothesis

H1: Teaching Portfolio significantly positively influence Academic Performance.

H2: Teaching Portfolio significantly positively influences Virtual Reality.

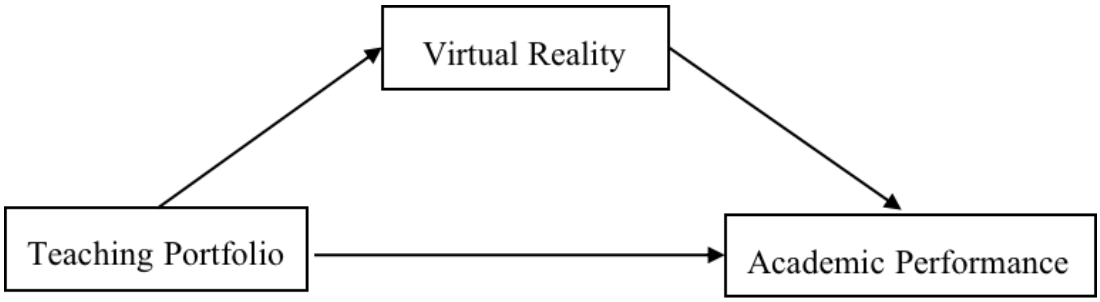
H3: Virtual Reality significantly positively influence Academic Performance.

H4: Virtual Reality mediates the relationship between teaching portfolio and academic performance.

1.4 Conceptual Framework

The conceptual framework (Figure 1) of this study is a complex network of variables designed to reveal the dynamics of the mediating influences of Teaching portfolio, academic performance and VR in the unique context of a Chinese university. These three independent variables represent the cornerstones of the educational process. Academic achievement is the result of the educational process. It measures the extent to which students meet predetermined learning objectives and standards. VR was introduced as a mediator variable reflecting the extent to which students integrate virtual reality technology into their educational experience. The framework recognizes the potential interplay between variables.

Figure 1: Conceptual Model



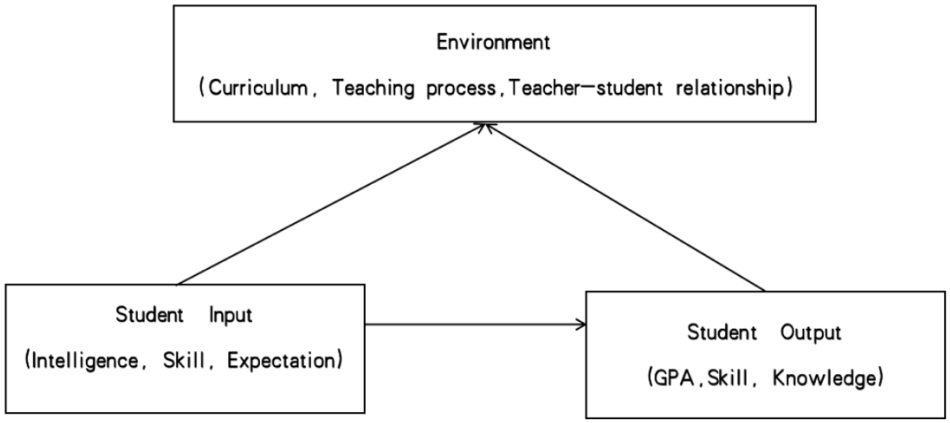
2 Literature review

2.1 Theory

There are two underlying theories in this study. The Technology Acceptance Model (TAM) is a well-established theoretical framework for technology adoption and user acceptance (Uche, Osuagwu, Nwosu & Otika, 2021). Conceived by Fred Davis in the late 1980s, TAM posits that individuals' inclination to embrace and employ technology is fundamentally shaped by their perceptions regarding its ease of use and perceived usefulness—these two core constructs, ease of use and perceived usefulness, form TAM's foundational pillars. In the context of study, TAM provides a potent theoretical lens through which to explore the perceptions and adoption of VR technology for educational purposes among university students in China.

The second theory is from Barymon (2022) proposed the I-E-O model (Inputs-Environment-Outputs model) based on the perspectives of students' inputs, outputs, and the educational environment they are exposed to, as shown in Figure 2. The core idea of the I-E-O model is that environment and The core idea of the I-E-O model is that the environment and the input variables jointly determine the output variables. The model is often used to guide the evaluation of teaching effectiveness in colleges and universities.

Figure 2: I-E-O Model



2.2 Independent Variable

The common thread in many definitions of E-Portfolios is the idea of an ongoing compilation of evidence of continuous learning that is submitted for assessing learning. Although E-Portfolios are viewed as a learner-centered approach to teaching and learning, teachers are key players because they are responsible for the design of the learning environment and the strategies employed within it, including student engagement. Research has shown that student-teacher interactions are associated with positive student interactions. engagement in learning, academic success, and feelings of support (Richardson and Radloff, 2014). According to research, student-teacher relationships are associated with academic performance, feelings of support, and active engagement in the learning process (Richardson and Radloff, 2014). Current E-Portfolio technology can bring together communities of students to create and share knowledge in a learning environment. According to research, teacher-student relationships are associated with academic achievement, feelings of support, and active participation in the learning process (Richardson and Radloff, 2014).

2.3 Dependent Variable

There are some common Evaluation Methods, such as Examinations and Tests, Assignments and Projects, Class Participation, GPA (Grade Point Average), and score et al. GPA (Grade Point Average) is a standardized numerical representation of a student's academic performance (U.S. Department of Education, 2009). The 4.0 grading scale is a common method used to calculate GPA in China university, with each letter grade corresponding to a specific point value (Prince, 2004).

2.4 Mediating Variable

Virtual Reality is a comprehensive technology with computer technology as its core, integrating scene modeling technology, stereoscopic display technology and natural interaction technology (Wang & Che, 2020). It can use computer simulation of three-dimensional images and sound to form a set of visual, auditory, tactile, etc. as a whole, can go beyond the time and space limitations of the virtual environment. With these characteristics, virtual reality technology, when widely used in education and teaching, has a great potential to stimulate students' learning motivation (White & Smith, 2019), enhance their learning experience, and promote scene learning and knowledge transfer. In desktop virtual reality environments, people usually use non-immersive devices such as keyboards, touchscreens,

mice, and computer monitors to interact with the learning environment.

3. Methodology

3.1 Population and Sampling

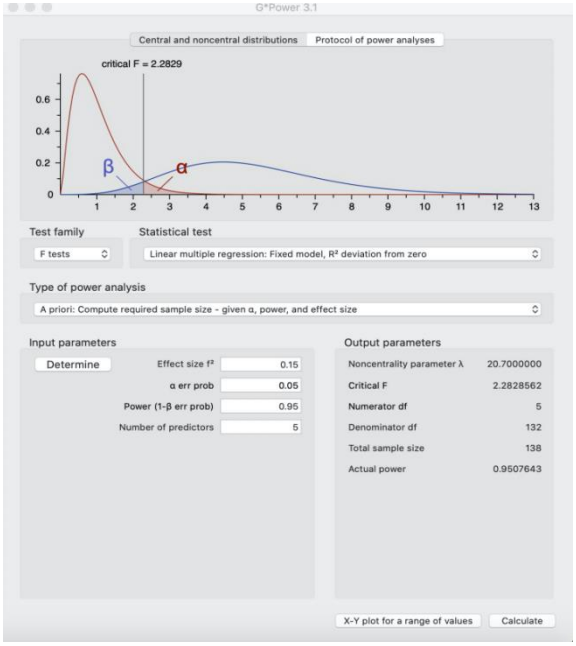
A population is defined as the entire group of people, events, or related things that the researcher wishes to investigate (Sekaran & Bougie, 2010). The participants of this paper were mainly students from 10 universities in China that offer virtual reality courses. Stratified sampling was conducted based on the major of "Virtual Reality Technology". This study selected 10 universities approved for the major of "Virtual Reality Technology" according to the Notice on the Announcement of the Record Filing and Approval Results of Undergraduate Majors of Ordinary Higher Education Institutions in 2020 issued by the Chinese Ministry of Education in February 2021.The specific school name will be shown in the questionnaire.

Subsequently, simple random sampling was employed. Four classes from each of the 10 universities were randomly selected, with students from the first to fourth years chosen as the research subjects. Surveys were distributed anonymously via the Wenjuanxing platform for remote participation by the selected subjects.

3.2 Sampling Size

G-Power stands out as a powerful and versatile statistical software widely employed for sample size calculation across diverse research designs and statistical analyses (Faul et al., 2007). The sample size determination for the present study was executed through a power analysis employing the G-Power software version 3.1 (Figure 3). The decision to use G-power's method to determine a minimum sample size of 138 students in this study is well-justified.

Figure 3: Simple size from G-Power



3.3 Instrument and Questionnaire

Virtual Reality Technology Scale (AVRTS)

The Attitudes toward Virtual Reality Technology Scale (AVRTS) was developed following a three-step procedure (Bunz, Seibert & Hendrickse, 2021). A total of 22 items clustered into a three-factor solution with the factors being “ease of use” (alpha=.858), “usefulness” (alpha=.857), and “enjoyment” (alpha=.919) and overall reliability of .910. Construct validity was established by correlating the AVRTS with the Technology Readiness Index and an access barrier scale, and internal validity was established by correlating the scale with its sub-scales.

Teaching Goals Inventory (TGI)

Teaching Goals Inventory (TGI) developed by Angelo and Cross (1993). Ulosevich（2016）state that the TGI (52 items) not only helps faculty to identify teaching goals, but also begins by articulating these goals in a precise manner so that faculty will have a clear understanding of exactly what it is they are trying to accomplish. The TGI assists teaching goals into six different goal clusters. In this paper three dimensions are selected, basic academic success skills, discipline-specific knowledge and skills, liberal arts and academic values. The

Cronbach'sαcoefficient of the TGI was 0.81. The model fitting was tested using confirmatory factor analysis, and the fitting indexes met the requirements ($\chi 2/df = 2.754$, RMSEA = 0.050, NFI = 0.90, RFI = 0.90, IFI = 0.94, TLI = 0.91, CFI = 0.92, GFI = 0.87, and AGFI = 0.90) (Ulosevich, 2016).

Classroom Ecology Inventory (CEI)

The Classroom Ecology Inventory (CEI) will be cited in teaching environment section which is more suitable for the development of colleges in China (SUN & Xie, 2008). CEI has 32-item classroom ecology inventory with six dimensions of cooperation and order (CO), teacher involvement (TI), teacher support (TS), classroom environment (CE), student involvement (SI) and relationship (RE) was finally determined. Its internal consistency reliability is 0.968 and its split-half reliability is 0.849 (Dong, Sun & Li,2019). The results of the validation factor analysis indicated that the inventory had high validity (Dong, Sun & Li,2019). (RESEA=0.069, ×²/df=2.742, IFI=0.96, CFI=0.926, TFI=0.919 NFI=0.889， GFI=0.818). Based on the physical classroom environment, this paper will refer to the CO, CE, and RE dimensions of the Classroom Environment Index (CEI).

Teaching instrument scale (TIS)

The Teaching instrument scale（TIS）is a scale with 20 items designed by Zhang and Lu (2019) to evaluate the teaching approach which consists of two sides: student-centered teaching style and teacher-centered teaching style. The Cronbach'sαcoefficient of the TIS was 0.81, and for the Inquiry-based learning, Cooperative Learning, Direct Instruction and Questioning it was 0.88, 073, and 0.77, 0.67 respectively (Zhang & Lu, 2019). The results show that this scale has good internal consistency reliability. Zhang and Lu (2019) find that the model fitting was tested using confirmatory factor analysis, and the fitting indexes met the requirements ($\chi 2/df = 2.745$, RMSEA = 0.051, NFI = 0.91, RFI = 0.90, IFI = 0.94, TLI = 0.93, CFI = 0.94, GFI = 0.83, and AGFI = 0.92).

Academic Performance

Finally, the cumulative grade point average (GPA) over the course of their studies to date was used to measure university students' academic performance (Imose & Barber, 2015）. The score was self-reported by the students. Consistent with the credit system used in China's higher education system (Yang, 2014). The GPA value ranged from 1 (low) to 5 (high),1 =less than 0.8, 2=0.8-1.6, 3=1.7-2.5, 4=2.6-3.4, 5= equal and greater than

3.4 Data Collection

The requirement of good validity of the structure. The scale was also based on a 5-point Likert scale, with "Never", "occasionally", "sometimes", "often", "always", corresponding to 1, 2, 3, 4, and 5.

Questionnaires were used to disseminate our survey and results were collected in October 2023 by Wenjuanxing. A total of 539 students from 10 universities participated. A total of 539 demographic data will be collected, and quantitative data will be collected through a well-designed questionnaire.

4. Results and findings

4.1 Respondent's Profile

Table 1 shows that 539 participants revealed 54% male and 46% female. Seniors were the largest group (32.8%), while juniors were the smallest (15%). East China Jiaotong University commands the largest proportion, with 66 respondents, constituting 12.2% of the total cohort. Conversely, the institution with the most modest representation is the Beijing University of Aeronautics and Astronautics (BUAA), boasting 43 participants, thus comprising 7.9% of the aggregate sample size. Furthermore, several universities exhibit comparable participant figures, exemplified by Hebei University of Engineering and Technology, Shanxi University of Media, and Jiangxi University of Finance and Economics, each enrolling 65, 50, and 57 individuals, respectively.

Table 1: Respondent's Profile

Demographic variable	Description	Frequency	Percent(%)
Gender	Male	291	54
	Female	248	46
Level	Freshman	117	21.7
	Sophomore	164	30.4
	Junior	81	15
	Senior	177	32.8
Universitity	Beijing University of Aeronautics and Astronautics (BUAA)	43	7.9
	Hebei University of Engineering and Technology	65	12
	Shanxi University of Media	50	9.2
	Dalian Neusoft Institute of Information	59	10.9
	Harbin University of Information Engineering	45	8.3
	East China Jiaotong University	66	12.2
	Jiangxi University of Finance and Economics	57	10.5
	Qingdao Agricultural University Haitu Academy	51	9.46
	Hubei Polytechnic University	49	9.09
	Yunnan University of Finance and Economics	54	10.01

4.2 Convergent Validity and Reliability

Convergent validity is defined as the degree of correlation between two conceptual measures (Amora, 2001). Two indicators, composite reliability (CR) and Average Variances Extracted (AVE) extracted value, are usually used in research to evaluate the convergent validity of a model. When the AVE value is greater than 0.5 and the CR value is greater than 0.7, the aggregation validity of the scale is high. As shown in Table 4.2, the factor loading of each observed variable are above the minimum standard of 0.5, and the calculated results of the combined reliability and mean variance extracted values are greater than 0.7 and 0.5, which mean the scale has a good convergent validity.

Table 2: Convergent Validity and Reliability

Domains	Items	Loadings	CR	AVE	VIF
VR Adopation	VR1	0.771	0.81	0.567	1.784
	VR2	0.715			1.715
	VR3	0.71			1.554
	VR4	0.75			1.749
	VR5	0.812			1.943
Academic Performance	AP1	0.891	0.854	0.636	1.731
	AP2	0.887			1.629
	AP3	0.738			1.846
	AP4	0.741			1.903
	AP5	0.71			1.51
Teaching Environment	TE1	0.824	0.863	0.646	2.122
	TE2	0.767			2.864
	TE3	0.745			2.737
	TE4	0.849			3.105
	TE5	0.829			2.787
Teaching Method	TM1	0.81	0.858	0.635	2.196

	TM2	0.823			2.413
	TM3	0.775			1.777
	TM4	0.794			2.273
	TM5	0.782			2.179
Teaching Objective	TO1	0.832	0.811	0.566	1.678
	TO2	0.742			1.527
	TO3	0.729			1.626
	TO4	0.754			1.653
	TO5	0.699			1.449

4.3 Discriminant Validity

Heterotrait-Monotrait (HTMT) is used to evaluate discriminant effectiveness (Henseler et al., 2015). The more conservative cut-off is 0.90, while the more stringent cut-off is 0.85 (Aburumman et,al., 2022). Hair and other researcher (2019) suggested that if the value is for greater than 0.85 or 0.90, discriminant validity is a concern. To prove that there is no discriminant validity in this study, the value is less than 0.90 is necessary. In Table 3, the HTML are less than 0.85, which means that the scale for this analysis has good discriminant validity and the scale has good discriminant validity.

Table 3: Convergent Validity and Reliability

	VR	**AP**	**TE**	**TM**	**TO**	**VR x TO**	**VR x TM**	**VR x TE**
VR								
AP	0.404							
TE	0.746	0.532						
TM	0.709	0.252	0.569					
TO	0.629	0.459	0.732	0.616				
VR x TO	0.292	0.177	0.243	0.247	0.252			

VR x TM	0.15	0.295	0.132	0.297	0.255	0.649		
VR x TE	0.331	0.065	0.429	0.115	0.228	0.682	0.384	

4.4 Hypothesis Testing

The hypothetical results shown in Table 4 have evidence of T-values, p-values. The H1 hypothesis is about the relationship between VR and Teaching Performance (β-path coefficient =0.104, t value =1.789) and the findings show that H1 is rejected. H2 shows the relationship between teaching Environment and Teaching Performance. The results show that H2 is positive and significant (β-path coefficient =0.252, t value =4.044). H3 predicted the relationship between teaching Method and academic performance and found that H3 was negative significant (β-path coefficient =0.004; t value =0.032). H4 presents the relationship between teaching objective and learning engagement. The results show that H4 is positive and significant (β-path coefficient =0.279; t value =5.505).

There are three hypotheses (Table 4) for mediating effect on the relationship of TP and AP. Hypothesis 5 shows the mediating effect of learning input on the learning effect of teaching objectives. (B-path coefficient =0.172; t value =3.152; p- value = 0.002). The results showed that H6 mediated the relationship and was accepted (b-path coefficient =0.241; T-value =4.92; p-value = 0.). Hypothesis H7 explored the mediation effect of VR adoption on the relationship between teaching environment (TE) and academic performance (AP). The standardized path coefficient (Std. beta = 0.087) is positive and statistically significant (p =0.022), indicating that VR adoption the influence of TE on AP.

Table 4: Results of hypothesis H1-H7 Testing

Hypothesis	**Path**	**Std.beta**	**Confidence intervals**		**T-value**	**F^2**	**P -values**	**Decision**
			2.50%	97.50%				
H1	VR-> AP	0.104	0.002	0.22	1.789	0.007	0.074	Rejected
H2	TE -> AP	0.252	0.122	0.385	4.044	0.044	0	Accepted

H3	TM -> AP	0.004	-0.105	0.107	0.032	0	0.975	Rejected
H4	TO -> AP	0.279	0.163	0.376	5.505	0.065	0	Accepted
H5	VR x TO -> AP	0.172	0.071	0.28	3.152	0.025	0.002	Accepted
H6	VR x TM -> AP	0.241	0.138	0.329	4.92	0.075	0	Accepted
H7	VR x TE -> AP	-0.087	-0.17	-0.008	2.304	0.011	0.022	Accepted

5. Conclusion and recommendations

5.1 Hypothesis Result and Discussion

This study investigates the effectiveness of teaching portfolios in virtual reality environments by examining the differences in the impact of different steps of teaching portfolios on student academic performance. Through data analysis, the following conclusions were drawn.

H1 and H3: Virtual reality technology and teaching methods do not directly make a significant difference in teaching outcomes.

H2: The instructional environment makes a significant difference in learning outcomes

H4: Teaching objective can have a significant impact on academic achievement

H5-H7: VR technology applied to teaching objectives, teaching methods, and teaching environment can have a significant mediating effect on learning outcomes.

The experimental results proved and extended the views of Halverson and Graham (2019). VR educational learning environments can enhance students' creativity and impact "It has been shown that learners are more motivated and learn better in virtual reality learning environments than in traditional classrooms (Shi, etal., 2022). For example, Halverson and Graham (2019) found that learning in a three-dimensional virtual environment was significantly more effective than in a traditional two-dimensional environment. Vergara etal (2019) argue that VR has become a driving force in providing students with a rigorous textbook-based learning or immersive educational environment as a way of demonstrating students' academic performance and learning outcomes.

There is also research related to the case of VR applied to lecture methods. In collaboration with classroom teachers, we applied a subset of these functional supports to design and deploy an immersive virtual reality experience to teach ocean acidification to students

(Fauville, etal., 2021). The results of this study suggest that virtual reality can be an effective way to teach students about ocean acidification, but that the effectiveness of this delivery may be lost in real-world use. The student learning experience is enhanced through the impact of these developments in the learning process (Huang,etal., 2020). A study conducted in a physical classroom through a 3D immersive virtual environment confirmed that learners tended to feel more confident, open, engaged, creative and understanding as they were definitely interested in learning (Huang,etal., 2021).

5.2 Implications

This study highlights the critical role of a conducive teaching and learning environment in facilitating student engagement in VR Adoption. Vocational universities should invest in the necessary infrastructure and resources to support VR integration. This may include VR equipped classrooms, reliable technical support, and well-maintained VR hardware and software. To fully utilize the potential of virtual reality technology in pedagogy, educators may need training and professional development opportunities. Institutions should invest in comprehensive programs that equip teachers with the necessary skills, knowledge, and proficiency to effectively integrate VR into their teaching practices.

5.3 Limitation

The variables of the study focused on those directly related to the Chinese educational context. While this focus is critical to addressing the research question at hand, it does represent a limitation in the breadth of variables considered. Future research efforts in this area could benefit from incorporating a wider range of variables, possibly from an international comparative perspective or synthesizing interdisciplinary aspects.

5.4 Future Research

Given the transformation potential of virtual reality (VR) technology in education, future research may delve deeper into the integration of VR into vocational university environments. There is a need for educators, policymakers, and institutions to examine the best ways to incorporate virtual reality into the educational process, its impact on learning engagement, and its potential to improve academic performance.

5.5 Conclusion

This study examines the relationship between Teaching Portfolio and Academic Performance, the mediating effect of VR. From the data analysis, it is found that VR has played a positive and essential role in the adjustment of Teaching Portfolio and Academic Performance. Therefore, if schools attach importance to the input of Teaching Portfolio, students' learning participation will be improved, and their academic performance will also be significantly improved.

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