

The Effects of an Artificial Intelligence Avatar-Based Virtual Reality Learning System on Vocational College Students' Performance and Motivation

Li Tan¹, Kien Tsong Chau^{1*}, Wan Ahmad Jaafar Wan Yahaya¹

¹ Centre for Instructional Technology and Multimedia, Universiti Sains Malaysia, Penang, Malaysia

² LinFen Vocational and Technical College. Linfen, Shanxi, China

Li Tan: tanli@student.usm.my

Kien Tsong Chau: Corresponding Author: kientsongchau@usm.my Wan Ahmad Jaafar Wan Yahaya: wajwy@usm.my

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ABSTRACT:

This study examined the effects of an Artificial Intelligence Avatar-Based Virtual Reality Learning System (pAInt-VR) on vocational college students' Performance and Motivation in learning History of Oil Painting. The study was conducted to address the limitations of conventional learning approaches, which may provide limited interaction and learning support for students when learning about artists, artworks, artistic styles, and historical contexts. The pAInt-VR system was developed to provide students with an interactive virtual gallery learning environment supported by an AI avatar. A quasi-experimental pretest–posttest control group design was employed. The pretest was used to assess students' prior knowledge, while Performance and Motivation were measured after the intervention using the post-test and the Instructional Materials Motivation Survey (IMMS), respectively. The learning system (pAInt-VR versus C-VR) was the independent variable, while students' Performance and Motivation were the dependent variables. A total of 160 vocational college students in China participated in the study, with 80 students in the experimental group and 80 students in the control group. Descriptive and inferential statistical methods were used to analyze the collected data. The results showed that students who learned with the pAInt-VR system demonstrated better Performance and higher Motivation than students who learned with the C-VR system. These findings suggest that integrating an AI avatar into a virtual reality learning environment can support students' learning of History of Oil Painting and provide a more engaging learning experience.

Keywords: Artificial Intelligence Avatar, Virtual Reality, History of Oil Painting, Performance, Motivation.

Introduction

The rapid development of digital technology has changed the way people communicate, work, and learn. More than 5.35 billion people around the world now use the Internet, showing the increasing influence of digital technology on

everyday life (Kemp, 2024). In education, digital technologies have provided new ways for students to access information and participate in learning activities. Artificial Intelligence (AI) and Virtual Reality (VR), in particular, have received increasing attention because they can provide

interactive learning experiences that are different from conventional classroom learning.

Virtual Reality has been increasingly applied in education to provide students with interactive and immersive learning environments. Through VR, students can explore digital learning spaces and interact with learning materials in ways that are difficult to achieve through textbooks and conventional classroom instruction. Such environments can support active exploration and provide students with more opportunities to participate in the learning process. However, existing VR learning systems still have limitations. Although they can provide immersive visual experiences, many systems offer limited instructional guidance, feedback, and personalized learning support. These limitations may make it difficult for students to understand learning content independently, especially when the subject requires continuous observation, interpretation, and reflection (Bos et al., 2022; Tsivitanidou et al., 2021).

Artificial Intelligence provides another opportunity to improve technology-supported learning. AI can provide immediate feedback, personalized learning experiences, and instructional guidance based on students' learning needs. Previous studies have indicated that AI can support students' learning performance and motivation by providing continuous learning assistance (Lin et al., 2023; Holmes et al., 2022). Nevertheless, AI and VR are often used separately in educational environments. Some VR systems provide immersive learning experiences but lack intelligent instructional guidance, while some AI applications mainly provide simple tutoring or question-answering functions (Bos et al., 2022; Tsivitanidou et al., 2021). Integrating AI with VR may therefore provide a learning environment that combines immersive exploration with continuous instructional support.

This issue is particularly relevant to the learning of History of Oil Painting. The subject helps art students understand the historical development of oil painting, recognize important artists and artworks, identify different artistic styles, and understand their artistic and cultural values (Birer et

al., 2025; Shen et al., 2025). Learning Post-Impressionism requires students not only to remember information but also to observe artworks, understand their historical backgrounds, and compare the styles of different artists. However, conventional learning approaches may provide limited opportunities for active exploration and interaction. Existing digital learning systems also rarely combine immersive virtual learning, AI avatar guidance, personalized feedback, and interactive communication specifically for learning History of Oil Painting (Jiang et al., 2021; Bos et al., 2022).

To address these limitations, the Artificial Intelligence Avatar-Based Virtual Reality Learning System (pAInt-VR) was developed for vocational college students in China. The system combines a virtual gallery with AI avatar guidance, interactive learning activities, and continuous feedback to support students in learning History of Oil Painting. Unlike the Conventional Virtual Reality Learning System (C-VR), pAInt-VR provides AI-supported guidance throughout the learning process. Therefore, this study examines whether the pAInt-VR system can better support vocational college students' Performance and Motivation in learning History of Oil Painting.

Research Questions

The following research questions were addressed in this study:

1. Do students using the pAInt-VR system demonstrate a significant difference in Performance compared with students using the C-VR system?
2. Do students using the pAInt-VR system demonstrate a significant difference in Motivation compared with students using the C-VR system?

Literature Review

Virtual Reality and Artificial Intelligence in Education

Virtual Reality (VR) has become an increasingly used technology in education because it can provide interactive and immersive learning experiences. VR allows students to enter

computer-generated environments and interact with digital learning materials in ways that are different from conventional classroom instruction. In educational settings, VR can support students in exploring learning content, observing visual information, and participating actively in learning activities. Such learning environments can make difficult or abstract content easier to understand through visualization and interaction (Freina & Ott, 2015; Slater & Sanchez-Vives, 2016).

VR has also been applied in different educational fields to create more learner-centered learning experiences. Students can explore virtual environments, control their learning process, and interact with learning materials rather than only receiving information from teachers or textbooks. Research has shown that VR can provide useful learning experiences by supporting visualization, interaction, and active participation (Bos et al., 2022). These characteristics are especially useful for subjects that require students to observe visual details and understand information within different contexts.

Artificial Intelligence (AI) can further support digital learning by providing personalized guidance and immediate feedback. AI-supported learning systems can adjust learning activities according to students' progress and provide support when students experience difficulties. Holmes et al. (2022) reported that AI-

supported adaptive learning can help students receive more personalized learning support. AI chatbots and virtual assistants can also answer questions, provide learning resources, and support students during the learning process, which may increase students' motivation and engagement (Lin et al., 2023). Interactive AI features may also make learning activities more engaging for students (Chang et al., 2022).

The integration of AI and VR provides opportunities to combine immersive learning with intelligent instructional support. AI-powered VR environments can allow students to explore digital learning spaces while receiving

guidance, explanations, and feedback during learning (Cinar et al., 2024). However, AI and VR are still often applied separately in existing educational environments. Some VR systems provide immersive experiences but limited intelligent guidance, while some AI systems focus mainly on tutoring or question-answering functions (Bos et al., 2022; Tsivitanidou et al., 2021). Therefore, integrating AI guidance into a VR learning environment may provide a more interactive and supportive learning experience for students.

Ai Avatar-Based Virtual Reality in Education

Virtual Reality (VR) has been increasingly used in education because it can provide interactive and immersive learning experiences. Unlike conventional classroom learning, VR allows students to explore virtual environments and interact with digital learning materials. It can support visualization, active participation, and learning through experience, which may help students understand learning content more effectively (Dalgarno & Lee, 2010; Merchant et al., 2014). However, VR alone may not always provide sufficient instructional guidance. Some VR learning environments focus mainly on immersive experiences and provide limited personalized support and immediate feedback during the learning process (Radianti et al., 2020; Makransky & Petersen, 2021).

Artificial Intelligence (AI) can provide additional support by offering personalized guidance and immediate feedback. AI-supported learning environments can respond to students' learning needs and provide assistance during learning activities (Lin et al., 2023; Holmes et al., 2022). AI avatars can further support interaction by serving as virtual learning guides. Through communication and guidance, students can receive learning support while participating in digital learning activities.

Combining AI avatars with VR may therefore provide a learning environment that integrates immersive exploration with intelligent learning support. Students can explore virtual environments while receiving guidance and

feedback from an AI avatar. However, AI and VR are still often applied separately in educational settings. Some VR systems emphasize immersive experiences but provide limited intelligent guidance, while AI applications often focus on tutoring or question-answering functions outside immersive environments (Bos et al., 2022; Tsivitanidou et al., 2021). Therefore, integrating AI avatar support into VR may provide students with a more interactive and supportive learning experience.

Performance and Motivation

Performance is an important learning outcome that reflects students' knowledge and understanding acquired during the learning process. Interactive and immersive learning environments can provide students with opportunities to explore learning materials and construct knowledge through active participation. Previous studies have shown that Virtual Reality can support students' learning experiences through visualization and interaction with virtual environments (Dalgarno & Lee, 2010; Merchant et al., 2014). Artificial Intelligence can further support learning by providing immediate feedback, personalized guidance, and continuous learning assistance, which may improve students' learning performance (Lin et al., 2023; Holmes et al., 2022). In learning the History of Oil Painting, these features may help students understand artists, representative artworks, historical backgrounds, and artistic styles through more active observation and exploration.

Motivation refers to students' interest, willingness, and persistence in participating in learning activities. Students with higher motivation are more likely to maintain attention, participate actively, and continue learning when they encounter difficulties. The ARCS Model of Motivation identifies four components of learning motivation: attention, relevance, confidence, and satisfaction (Keller, 1987). These components explain how instructional activities can attract students' attention, connect learning content with their needs, build confidence, and provide satisfaction during learning. Interactive visual

experiences, learning guidance, and feedback in virtual learning environments may therefore support students' motivation and continued engagement in learning activities.

Experiment design

This study employed a quasi-experimental research design. The experimental group learned using the Artificial Intelligence Avatar-Based Virtual Reality Learning System (pAInt-VR), while the control group learned using the Conventional Virtual Reality Learning System (C-VR). Both groups followed the same learning content and learning schedule for the History of Oil Painting, with a focus on Post-Impressionism. The main difference between the two groups was that the pAInt-VR system provided AI avatar-based guidance, interaction, and feedback, while the C-VR system did not include these AI avatar-based features.

Experiment participants

The participants in this study were first-year vocational college art students from two vocational colleges in Shanxi Province, China. A total of 160 students participated in the study, with 80 students in the experimental group and 80 students in the control group. Before the treatment, students completed a

pretest on the History of Oil Painting. Students who scored below 25 points were selected to ensure that they had limited prior knowledge of the learning content.

Experiment instruments

This study used pre-tests and post-tests to assess students' Performance in learning the History of Oil Painting. The Oil Painting History Knowledge Test consisted of 20 multiple-choice questions, with 5 points for each correct answer and a total score of 100 points. The test covered artists and representative artworks, artistic styles, artwork identification, and related characteristics of Post-Impressionism. Both the pre-test and post-test lasted 40 minutes. The pre-test was administered before the experimental treatment, while the post-test was administered after the completion of the treatment. The same questions were used in both

tests, but the order of the questions was changed in the post-test.

The Instructional Materials Motivation Survey (IMMS) was used to measure students' Motivation during the learning process. The IMMS was based on Keller's ARCS Model of Motivation (Keller, 1987), which includes four dimensions: Attention, Relevance, Confidence, and Satisfaction. The questionnaire consisted of 20 items and used a five-point Likert scale. Students were given 20 minutes to complete the questionnaire.

The IMMS assessed students' Motivation in four dimensions. The Attention items measured whether the learning activities attracted and maintained students' attention. The Relevance items measured whether students considered the learning content relevant to their learning needs. The Confidence items measured students' confidence in completing the learning activities. The Satisfaction items measured students' satisfaction with the learning experience. Students completed the IMMS after the experimental treatment.

Experiment procedures

The intervention lasted seven weeks. In the first week, students received an introduction to the study and the learning systems. They were informed about the learning activities and their right to withdraw from the study at any time. The students were also introduced to the main functions and operation of the pAInt-VR and C-VR systems before the formal learning activities began.

During the next five weeks, both groups followed the same learning schedule and completed five learning topics on Post-Impressionism. Each week focused on one artist: Vincent van Gogh, Paul Cézanne, Paul Gauguin, Georges Seurat, and Henri Rousseau. The experimental group learned with the pAInt-VR system, while the control group learned with the C-VR system. Both groups studied the same learning content and were given the same learning time. Students explored representative artworks, artistic styles, and historical backgrounds in the virtual gallery. Each

topic also included a corresponding quiz to review and reinforce the learning content. The main difference between the two groups was that the experimental group received

AI avatar-based guidance, interaction, and feedback, while the control group completed the learning activities without these AI avatar-based features.

In the seventh week, both groups completed the post-test to assess their Performance in learning the History of Oil Painting. They also completed the Instructional Materials Motivation Survey (IMMS) to assess their Motivation.

Data Analysis

The collected data were statistically analyzed using IBM SPSS Statistics 27.0. Descriptive and inferential statistics were used to examine the effects of the pAInt-VR system on students' Performance and Motivation. Before the main analysis, the data were screened for missing data, normality, and homogeneity of variance to ensure that the assumptions for parametric analysis were met.

Analysis of Covariance (ANCOVA) was used to determine whether significant differences existed between the experimental group and the control group in terms of Performance and after controlling for the pre-test scores. Motivation was analyzed using one-way Analysis of Variance (ANOVA). The significance level was set at $p < .05$. Effect size (η^2) was also reported to indicate the magnitude of the differences between the two groups.

Results

Results for RQ1: Impact on Performance

To examine the effect of the pAInt-VR system on students' Performance, one-way Analysis of Covariance (ANCOVA) was used to compare the experimental group and the control group. Students' Performance scores were used as the dependent variable, while the learning system (pAInt-VR vs. C-VR) was used as the independent variable, with pre-test Performance scores included as the covariate. As shown in Table 1, the experimental group obtained a higher

mean Performance score ($M = 78.60$, $SD = 9.80$) than the control group ($M = 69.40$, $SD = 10.70$). The ANCOVA results showed a significant difference in Performance between the two groups, $F(1, 158) = 32.16$, $p < .001$, $\eta^2 = .169$.

Table 1. ANCOVA Results for Performance between the Two Groups

Group	N	Mean	SD	F	η^2
Experimental Group	80	78.60	9.80	32.16*	.169
Control Group	80	69.40	10.70		

* $p < .001$

Results for RQ2: Impact on Motivation

To answer Research Question 2, one-way Analysis of Variance (ANOVA) was used to compare students' Motivation between the experimental group and the control group. Students' Motivation scores were used as the dependent variable, while the learning system (pAInt-VR vs. C-VR) was used as the independent variable. As shown in Table 2, the experimental group obtained a higher mean Motivation score ($M = 82.35$, $SD = 8.90$) than the control group ($M = 73.10$, $SD = 9.75$). The ANOVA results showed a significant difference in Motivation between the two groups, $F(1, 158) = 39.28$, $p < .001$, $\eta^2 = .199$. This result indicates that students using the pAInt-VR system demonstrated higher Motivation than students using the C-VR system.

Table 2. ANOVA Results for Motivation between the Two Groups

Group	N	Mean	SD	F	d
Experimental Group	80	82.35	8.90	39.28*	.199
Control Group	80	73.10	9.75		

* $p < .01$

Discussion

Discussion on the results of RQ1

The findings of this study showed that students who learned with the pAInt-VR system achieved higher Performance than students who learned with the C-VR system. This finding is consistent with previous studies showing that Virtual Reality can support students' learning outcomes by providing interactive and visual learning experiences. Dalgarno and Lee (2010) explained that virtual environments provide opportunities

for students to interact with learning content, while Merchant et al. (2014) found that VR-based instruction can have positive effects on students' learning outcomes.

The higher Performance of the experimental group may be related to the combination of VR learning and AI-supported guidance in the pAInt-VR system. Although VR provides an interactive learning environment, some VR systems provide limited instructional guidance, immediate feedback, and personalized learning support (Radianti et al., 2020; Makransky & Petersen, 2021). AI can provide additional support through immediate feedback, personalized learning experiences, and continuous learning assistance. Previous studies have shown that these AI-supported functions can improve students' learning performance by supporting individual learning needs (Lin et al., 2023; Holmes et al., 2022).

These functions are useful for learning the History of Oil Painting because students need to observe representative artworks, understand historical backgrounds, and compare different artistic styles. In the pAInt-VR system, students could explore learning content in the virtual gallery while receiving AI avatar-based guidance and feedback. This provided more learning support than the C-VR system, which did not

include AI avatar-based guidance. Previous research also suggests that VR can support students' exploration of artworks, artistic styles, and historical contexts through interactive virtual environments (Jiang et al., 2021; Tsivitanidou et al., 2021). Therefore, the combination of the virtual gallery and AI avatar-based learning support may explain why the pAInt-VR group demonstrated higher Performance than the C-VR group.

Discussion on the results of RQ2

The findings of this study showed that students who learned with the pAInt-VR system demonstrated higher Motivation than students who learned with the C-VR system. This finding is consistent with previous studies showing that Virtual Reality can increase students' interest and motivation by providing interactive and

immersive learning experiences. VR environments can encourage active participation and provide students with more engaging learning experiences than conventional learning approaches (Bos et al., 2022; Jiang et al., 2021; Tsivitanidou et al., 2021).

The higher Motivation of the experimental group may also be explained by the AI-supported features of the pAInt-VR system. AI can provide immediate feedback, personalized learning support, and continuous guidance according to students' learning needs. Previous studies have shown that AI-supported learning can improve students' motivation and engagement by providing more personalized and interactive learning experiences (Lin et al., 2023; Holmes et al., 2022). These functions may help students maintain their interest and willingness to continue learning the History of Oil Painting.

The motivational design of the pAInt-VR system is also supported by the ARCS Model of Motivation. The model includes four components: Attention, Relevance, Confidence, and Satisfaction. In the pAInt-VR system, immersive visual content and interaction can attract students' Attention, personalized learning activities can improve Relevance, AI avatar guidance and feedback can support Confidence, and feedback on learning progress can increase Satisfaction. Previous research has also shown that the ARCS model can support higher student satisfaction, better learning outcomes, and more positive attitudes toward learning in digital learning environments (Song & Keller, 2021). Therefore, the combination of immersive VR learning, and AI avatar-based support may explain why students using the pAInt-VR system demonstrated higher Motivation than students using the C-VR system.

Significance of the Research

Firstly, this study developed the Artificial Intelligence Avatar-Based Virtual Reality Learning System (pAInt-VR) for vocational college students learning the History of Oil Painting. The system provides an interactive virtual gallery and integrates AI avatar-based guidance, explanations,

interaction, and feedback during the learning process. The development of the pAInt-VR system provides a new technology-supported approach for learning Post-Impressionism and offers an alternative to conventional classroom instruction.

Secondly, this study contributes to vocational art education by integrating Artificial Intelligence and Virtual Reality into the learning of the History of Oil Painting. Previous research in this area has been relatively limited, particularly among vocational college students and in the learning of Post-Impressionism. By examining the effects of the pAInt-VR system on students' Performance and Motivation, this study provides useful information for educators and curriculum developers who are interested in applying AI-and VR-supported learning in art education.

Thirdly, this study provides a theoretical and instructional reference for the design of AI-supported VR learning environments. The pAInt-VR system combines immersive virtual learning with AI avatar-based guidance, personalized support, interaction, and feedback. These features may provide useful guidance for researchers and educators in designing future technology-supported learning systems for vocational education and other art-related learning contexts.

Implications of the Research

Implications for Future Research

Considering the potential of the pAInt-VR system shown in this study, future research could further explore its application in different art subjects, educational levels, and geographical regions. Future studies could also examine how specific features of the pAInt-VR system, such as AI avatar guidance, interaction, and feedback, influence different groups of students. Moreover, longitudinal studies could be conducted to examine the long-term effects of AI Avatar-Based Virtual Reality learning on students' Performance and Motivation. This is particularly relevant because the present study was limited to first-year vocational college art students in Shanxi

Province and used a seven-week intervention.

Furthermore, future research could continue to improve the integration of Artificial Intelligence and Virtual Reality in art education. The AI avatar could provide more adaptive guidance and personalized feedback according to students' learning needs and progress. Future studies could also investigate the application of pAInt-VR in other areas of art education beyond the History of Oil Painting and Post-Impressionism. The combination of immersive VR environments and intelligent AI support may provide new opportunities for developing more personalized and interactive learning environments for vocational college students.

Recommendations for Future Research

This study identifies several areas that can be further explored in future research. These recommendations are mainly based on the limitations of the present study and may help improve the future development and application of AI Avatar-Based Virtual Reality learning environments.

Firstly, future research could further improve and develop the pAInt-VR system for different art subjects and learning content. The current system was specifically designed for learning the History of Oil Painting, particularly Post-Impressionism. Future studies could develop similar AI Avatar-Based Virtual Reality learning systems for other areas of art education and examine whether the system can support students' learning in different learning contexts.

Secondly, future studies could use qualitative methods, such as interviews and classroom observations, to better understand students' learning experiences with the pAInt-VR and C-VR systems. The present study mainly used quantitative instruments to measure students' learning outcomes. Qualitative data could provide more detailed information about how students experience AI avatar guidance, interaction, feedback, and virtual gallery exploration during the learning process.

Thirdly, future research could include students from more vocational colleges and different geographical regions in China. The present study focused on first-year vocational college art students in Shanxi Province. Future studies could include students from other provinces, educational levels, and academic disciplines to examine whether similar results can be found in different learning contexts.

Conclusion

Overall, this study developed the Artificial Intelligence Avatar-Based Virtual Reality Learning System (pAInt-VR) for vocational college students learning the History of Oil Painting, particularly Post-Impressionism, to support students' understanding of artists, representative artworks, artistic styles, and historical backgrounds. The integration of Artificial Intelligence and Virtual Reality provides students with an interactive virtual gallery supported by AI avatar-based guidance, interaction, and feedback, which can support students' learning of the History of Oil Painting. Furthermore, the pAInt-VR system shows potential in improving students' Performance and Motivation, creating a more interactive, engaging, and supportive learning environment for vocational college students.

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Author Declaration

The authors declare that this manuscript is original, has not been published previously, and is not under consideration for publication elsewhere.

Kien Tsong Chau: Corresponding Author: kientsongchau@usm.my
Wan Ahmad Jaafar Wan Yahaya: wajwy@usm.my

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