



Moderated mediating effect of professor-student interaction on the relationship between learning presence, learning flow, and learning satisfaction in metaverse-based practical classes for airline service major students

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ABSTRACT

Introduction. The advancement of digital communication has driven demand for virtualized services across sectors such as gaming, education, and business, consequently propelling the growth of the metaverse industry. Metaverse-based learning environments play a crucial role in education by influencing learner and instructor motivation. By simulating virtual laboratories and real-world scenarios, the metaverse enhances educational quality through interactive experiences. This study focuses on aviation service majors, investigating how metaverse technologies impact learning outcomes and student satisfaction. It underscores the need for empirical insights and theoretical frameworks to better understand professor-student interactions within these contexts and optimize educational practices.

Methods. The participants in this study were 137 airline service major students from four universities. Data were collected from freshmen (31.4%), sophomores (38.0%), juniors (29.2%), and seniors (1.5%) students majoring in airline service. This study used SPSS Win.21.0 statistics programs to conduct the frequency test, reliability and correlation tests. For the moderated mediation analysis, 'Model 14 of PROCESS macro ver.4.0' was used as the statistical method.

Results. Professor-student interaction was found to have conditional indirect effects on the relationship between learning presence and learning satisfaction through learning flow that were significant ($p < .01$) when the professor-student interaction values were .0000 (.0302~.2912) and .1161 (.0844~.3865), respectively. Therefore, the moderated mediation effect of resilience was verified.

Conclusions. This study found that airline service major students with high professor-student interaction have increased learning flow. The results of this study indicate that students' professor-student interaction should be fostered and reinforced with the goal of increasing improving metaverse' learning presence and increasing their learning flow.

KEYWORDS

learning presence, learning flow, learning satisfaction, professor-student interaction, airline major student

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INTRODUCTION

With the widespread adoption of digital communication in our increasingly contactless society, there has been a significant surge in the demand for virtualized services across various sectors such as gaming, education, business, and consumerism. This trend has catapulted the metaverse industry into the forefront [1].

In the realm of education, particularly within Metaverse-based learning environments, the motivation of both learners and instructors emerges as a critical determinant of educational effectiveness and sustainability. According to Ryan & Deci's study [2], intrinsic motivation among learners plays a pivotal role in fostering active engagement and achieving substantial learning outcomes. As the demand for online learning continues to escalate, the Metaverse plays a crucial role in enhancing education by replicating virtual laboratories and real-world work environments. Utilizing advanced graphical interfaces, Metaverse technology facilitates interactive educational activities, promoting engagement among learners and between instructors and students alike [3]. This learner-centric approach not only deepens educational immersion but also cultivates a more interactive and participatory learning experience.

In specialized fields such as aviation service majoring, which prepares professionals for the airline services industry, educational systems are meticulously designed to emphasize both specialized knowledge and practical skills [4]. Satisfaction with practical training in these programs hinges on achieving course objectives and learning outcomes, which in turn motivate learners and facilitate the acquisition of specialized knowledge. Moreover, satisfaction with practical training significantly influences overall satisfaction within the major. Lee's study [5] revealed offline classes demonstrate higher learning effectiveness due to professor-student interaction, but the level of immersion in offline classes has been found to be lower than that in online lectures. To address these challenges, attention has turned towards innovative learning tools, with the Metaverse gaining prominence. Previous studies have outlined future research directions for aviation service majoring, particularly in exploring Metaverse applications [6; 7] and its role in other educational disciplines [8].

Despite this, gaps remain, notably in understanding how factors like learning presence, flow, satisfaction, and professor-student interaction influence aviation service majoring students' engagement with the Metaverse. In conclusion, this research seeks to address these gaps by investigating the moderated mediation effect of professor-student interaction on learning presence, learning flow, and learning satisfaction in Metaverse-Based Practical Classes for Airline Service Major Students.

Understanding these dynamics is crucial as Metaverse technologies redefine educational paradigms, offering immersive learning environments that can significantly impact student engagement and interaction with course material. By shedding light on these relationships, this study aims to enhance educational practices tailored to the unique needs of airline service majoring students, ultimately preparing them more effectively for careers in the aviation industry.

Theoretical Background

1. Relationship between learning presence and learning satisfaction

Learning presence can be defined as the degree to which students are actively engaged and participating in their learning process. It encompasses the overall sense of being involved and present in the learning environment. Learning satisfaction, on the other hand, refers to students' overall contentment and positive perception of their educational experiences, including enjoyment of classes, interactions with faculty and peers, and other related aspects.

Previous research has demonstrated a strong relationship between learning presence and learning satisfaction. Garrison, Anderson, & Archer's study [9] Community of Inquiry (CoI) framework suggests that learning presence significantly contributes to students' learning satisfaction. Higher levels of learning presence, where students feel more engaged and connected with the learning material and the educational community, are associated with increased learning satisfaction. Shea, & Bidjerano's study [10] found that a robust learning presence enhances overall learning satisfaction by fostering a conducive learning environment. Similarly, Richardson, et al. [11] found that students

who perceive higher levels of learning presence in online courses tend to report greater satisfaction with their learning experiences.

Recent studies in Korea have also explored the relationship between learning presence and learning satisfaction, particularly in the context of metaverse-based learning environments. The integration of metaverse platforms in education has been shown to enhance learning presence by providing immersive and interactive learning experiences. Chang's study [12] investigated the effect of presence in metaverse-based classrooms on usage's satisfaction. Their study found that higher metaverse remote presence was associated with higher user satisfaction, and mediating variable, immersion and enjoyment, had a significant dual mediating effect relationship metaverse remote presence and user satisfaction. Another study by Jeong [13] focused on the relationship among teaching presence, interaction, and class satisfaction, finding that both teaching presence and teacher-student interaction significantly influenced class satisfaction, with interaction showing a higher relative influence.

Overall, these studies highlight the importance of learning presence in enhancing learning satisfaction. Garrison, Anderson, & Archer [9] emphasize its role as a critical component of the CoI framework, while Shea, & Bidjerano [10] demonstrate its impact on creating an effective learning environment. Richardson, et al. [11] further confirm that greater perceived learning presence in online courses leads to higher satisfaction. Additionally, Cho, & Han [14] found that perceived social presence, closely related to learning presence, significantly predicts learning satisfaction in an online learning community. Given these findings, it is reasonable to hypothesize that fostering a strong learning presence in metaverse environments may enhance learning satisfaction in this study. By providing immersive and interactive learning experiences, metaverse technologies have the potential to engage students more deeply in their learning process, thereby contributing to higher overall satisfaction.

2. The mediating effect of learning flow

Learning flow is defined as a state of optimal experience where an individual is fully immersed in an activity, experiencing high levels of concentration, control, and enjoyment [15]. It is crucial for college students, as learning flow has become a significant factor in achieving academic success. This is because students believe that being deeply engaged in their studies can significantly enhance their learning outcomes. According to the results of a study on student engagement, many educators observed that students who frequently experience learning flow tend to achieve higher academic performance [16]. In a survey on «factors influencing academic success» targeting university students, 65% (195 out of 300) students responded that experiencing learning flow during study sessions positively impacted their grades, indicating that learning flow plays a crucial role in academic achievements [17].

As the importance of engagement in academic success becomes increasingly emphasized, students' ability to experience learning flow is not only closely related to their motivation but also affects their academic stress. Thus, in an educational context, fostering learning flow has attracted attention as one of the key factors for effectively increasing academic motivation and reducing academic stress. The more frequently students experience learning flow, the better they can enhance their motivation and improve their academic performance, while also alleviating academic stress [18]. Park, & Lee [19] identified the effects of learning flow on academic achievement and found that student's learning flow has a negative effect on academic achievement. Similarly, Jeong's study [20] on relationship education service quality, class flow and career preparation behavior in airline service department. Considering these finding, education service quality had significant influence class flow and had full mediating effect between education service quality and career preparation behavior.

Despite the academic attention that has already been given to learning flow for achieving academic success, there have been few studies verifying the mediating effect of learning flow in the relationship between learning presence and learning satisfaction. In a recent study indicates that understanding this mediating effect can provide valuable insights into how educational strategies can be developed to enhance student engagement and learning effectiveness [21]. Based on these prior results, it can be predicted in this study that learning presence may increase learning satisfaction through learning flow in addition to the direct impact between learning presence and learning satisfaction.

3. Moderating effect of professor-student interaction

Professor-student interaction refers to the quality of interpersonal dynamics where individuals express themselves externally and are recognized by others. This interaction is crucial in higher education as it fosters a supportive learning environment, enhances communication, and provides guidance and feedback essential for student engagement and learning outcomes.

Research both internationally and in Korea underscores the significance of professor-student interaction in shaping educational experiences. Internationally, studies by Estep et al. [22] and Helm [23] have demonstrated that positive interactions with professors correlate with higher levels of student satisfaction, expectancy for success and values/goals, academic self-efficacy and resiliency. These studies highlight the importance of supportive interactions in improving students' perceptions of their educational experiences and enhancing their overall academic engagement. Yoon., & Jun[24] has shown that various aspects of professor-student interaction, such as moderated mediating effects of career maturity, major-aptitude congruence, and faculty-student interaction on the relationship between college graduate employees' perceived college life satisfaction and post-graduation job satisfaction. Additionally, Kim & Kim [25] found that effective interactions with professors improve online learning system satisfaction and student learning outcomes among Korean university students. These findings emphasize the role of professor-student interaction in enhancing educational quality and student satisfaction in both international and domestic contexts.

In the context of moderated mediation, variables such as learning presence, learning flow, and professor-student interaction play critical roles. Learning presence, which encompasses cognitive, social, and teaching presence [9], influences the degree to which students actively engage in their learning process. Learning flow, characterized by deep immersion and optimal challenge [17], mediates the relationship between learning presence and learning satisfaction.

This study aims to explore the moderated mediation effect of professor-student interaction in the relationship between learning presence and learning flow within metaverse environments. Specifically, it seeks to examine whether professor-student interaction moderates the mediating role of learning flow in the association between learning presence and subsequent learning satisfaction. Thus, based on the literature review above, this study aims to verify the moderating effect of professor-student interaction between learning presence and learning flow. It also aims to identify whether professor-student interaction moderates the mediating effects of learning flow in the link between learning presence and learning satisfaction.

RESEARCH METHODS

1. Research model

The research model in the education field is shown in Figure 1. It aims to verify the moderated mediation (conditional indirect effect) by examining learning flow as the mediating variable between learning presence and learning satisfaction. In this model, professor-student interaction moderates the strength or direction of the mediating effect of learning flow.

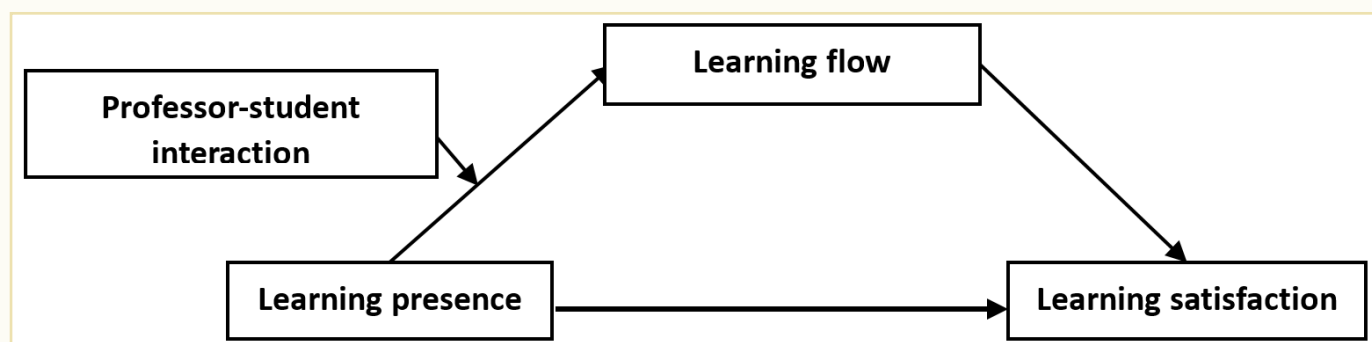


Figure 1 Conceptualized research model

2. Sample and Data Collection

An online survey was conducted with airline service major students at universities in Seoul and Seongnam, South Korea, between May 31 and June 15, 2023. The target population included South Korean students at various university levels. The survey, distributed online, offered a small gift to participants who completed the questionnaires. A total of 161 usable responses were collected. Most participants were female (95.5%), reflecting the demographic of the airline service major. The sample included freshmen (31.4%), sophomores (38.0%), juniors (29.2%), and seniors (1.5%). Frequency analysis was performed to examine the demographic characteristics of the participants.

3. Research tools

3.1. Learning presence

Measured using a scale adapted from Kim and Park [26] and Jung [27], this includes items such as 'Friendly towards other students' and 'Tend to help when students ask for assistance.' The scale has six items rated on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree). The reliability, as indicated by Cronbach's α , was .959.

3.2. Learning flow

Recent studies have used a self-rated learning flow scale for airline service major students [28]. This study adapted five positive self-esteem items from Jeong's study [21], including 'I can participate more engagingly through the Metaverse,' 'I am more interested,' and 'I didn't feel bored.' The scale used a 5-point Likert scale from 1 (strongly disagree) to 5 (strongly agree), with higher scores indicating greater learning flow. The reliability of the learning flow scale in this study was Cronbach's α = .959.

3.3. Learning satisfaction

Measured using a single dimension adapted from Lee [29], with items like 'Overall satisfied with the class' and 'Satisfied with the various activities.' This self-report questionnaire uses a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), and the reliability was Cronbach's α = .959.

3.4. Professor-student interaction

Adapted from [30; 31], this includes items such as 'Enjoyed interacting with the professor' and 'Satisfied with the interaction with the professor in the Metaverse.' The scale has five items rated on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree), with Cronbach's α = .951.

4. Data analysis tools

Collected data in this study were analyzed using two primary statistical software tools. First, SPSS Win version 21.0 was used for three main statistical methods: descriptive statistics (including frequency tests), reliability testing for internal consistency, and Pearson correlation analysis to examine the strength and direction of linear relationships among variables. Second, PROCESS macro version 4.0 was used to verify the mediation and moderation analyses. The moderated mediation effect was assessed using a bootstrapping test with 5,000 samples at a 95% confidence level. Specifically, the bootstrapping analysis was conducted under three conditions: -1SD, Mean, +1SD, to evaluate the conditional effects.

RESULTS

1. Moderated mediating effect of professor-student interaction

The procedure from Model 7 of the PROCESS macro for SPSS, developed by Hayes was adapted to examine whether appearance satisfaction moderates the mediating effect of learning flow on the relationship between learning presence and learning satisfaction. The moderated mediation effect was assessed using the bootstrapping method with 5,000 samples and a 95% confidence interval.

Table 1 presented the results of the moderated mediation analysis. Direct effects among learning presence, learning flow, and learning satisfaction were found to be statistically significant. Specifically, learning presence had a significant positive effect on learning satisfaction ($\beta = .3275$, $p = .0000$) and learning flow had a significant positive effect learning satisfaction ($\beta = .6295$, $p = .0000$). Furthermore, learning presence had a significant positive effect on learning flow ($\beta = .5002$, $p = .0000$), indicating that learning flow mediated the relationship between learning presence and learning satisfaction. The interaction term between learning presence and professor-student interaction significantly affected learning flow ($\beta = .1027$, $p = .0067$). The increase in R^2 ($\Delta R^2 = .0089$, $p = .0062$) due to the interaction term indicates professor-student interaction moderates the relationship between learning presence and learning flow.

The conditional effect of learning flow based on the level of professor-student interaction was significant at the Mean percentiles ($-.2445$, $p = .0000$) and the $+1SD$ percentiles ($-.3591$, $p = .0000$), but not significant at the $-1SD$ percentiles ($-.0822$, $p > .05$). Specifically, the effect of learning presence on learning flow was significant when professor-student interaction ranged between $.0000$ (middle group) and 1.1161 (high group), but not significant when it was -1.1161 (low group). In other words, the impact of the learning presence on learning flow decreases when professor-student interaction is at higher levels, approximately around $.0000$ (middle group) and $+1.1161$ (high group) on a 5-point Likert scale. Conversely learning presence does not influence learning flow when professor-student interaction is low, around -1.1161 (low group).

The Johnson-Neyman method, a type of floodlight analysis [37], was used to verify the specific area in which the moderating effect was conditionally significant according to the value of moderating variable. The moderating effect was significant when the value of professor-student interaction was above $-.9987$, encompassing 75.1825% of the respondents.

Table 1

Analysis of the moderated mediation effect of Professor-student interaction on the relationship among learning presence, learning commitment, and learning satisfaction

Mediating variable model (DV: Learning flow)						
Variables	B	SE	t value	p	LLCI*	ULCI**
Constant	3.9299	.0363	108.3237	.0000	3.8581	4.0016
Learning presence	.2445	.0607	4.0271	.0001	.1244	.3646
Professor-student interaction	.5002	.0411	12.1706	.0000	.4189	.5815
Learning presence X Professor-student interaction	.1027	.0369	2.7838	.0062	.0297	.1757
Dependent variable model (DV: Learning satisfaction)						
Variables	B	SE	t value	p	LLCI*	ULCI**
Constant	1.5507	.1963	7.8979	.0000	1.1624	1.9391
Learning presence	.3275	.0501	6.5345	.0000	.2284	.4266
Learning flow	.6295	.0488	12.9009	.0000	.5330	.7260
Increased R ² with Interaction						
Interaction item	R ²		F		p	
Learning presence X Professor-student interaction	.0089		7.7495		.0062	
Conditional effects of the focal predictor at values of the moderator(s)						
Professor-student interaction	Effect	se	t	p	LLCI*	ULCI**
-1.1161	.1299	.0741	1.7513	.0822	-.0168	.2765
.0000	.2445	.0607	4.0271	.0001	.1244	.3646
1.1161	.3591	.0726	4.9489	.0000	.2156	.5027
Moderator value defining Johnson-Neyman significance region						
Appearance satisfaction	Below(%)			Above(%)		
-.9987	24.8175			75.1825		

Conditional effects of focal predictor of values of the moderator						
Professor-student interaction	Effect	se	t	p	LLCI*	ULCI**
-1.6300	.0771	.0864	.8916	.3742	-.0939	.2481
-1.4820	.0923	.0826	1.1164	.2663	-.0712	.2557
			..	..		
.4412	.2898	.0625	4.6376	.0000	.1662	.4134
.5892	.3050	.0640	4.7649	.0000	.1784	.4316
.7371	.3202	.0660	4.8554	.0000	.1898	.4507
.8851	.3354	.0683	4.9130	.0000	.2004	.4705
1.0330	.3506	.0709	4.9426	.0000	.2103	.4909
1.1809	.3658	.0739	4.9494	.0000	.2196	.5120
1.3289	.3810	.0772	4.9382	.0000	.2284	.5336

As presented in Figure 2, the visualization of the conditional effect of learning flow involved categorizing professor-student interaction into low, middle, and high value groups. Learning flow increased proportionally with learning presence across these groups. Specifically, in the low (-1.1161) professor-student interaction group, learning flow showed minimal increase, while in the middle (0.0000) and high (1.1161) professor-student interaction groups, learning flow increased more prominently. The group that exhibited the most significant increase in learning flow was the high professor-student interaction. This suggests that as learning presence increases, learning flow tends to increase, with the high professor-student interaction group showing the greatest enhancement in learning flow even under similar increases in learning presence.

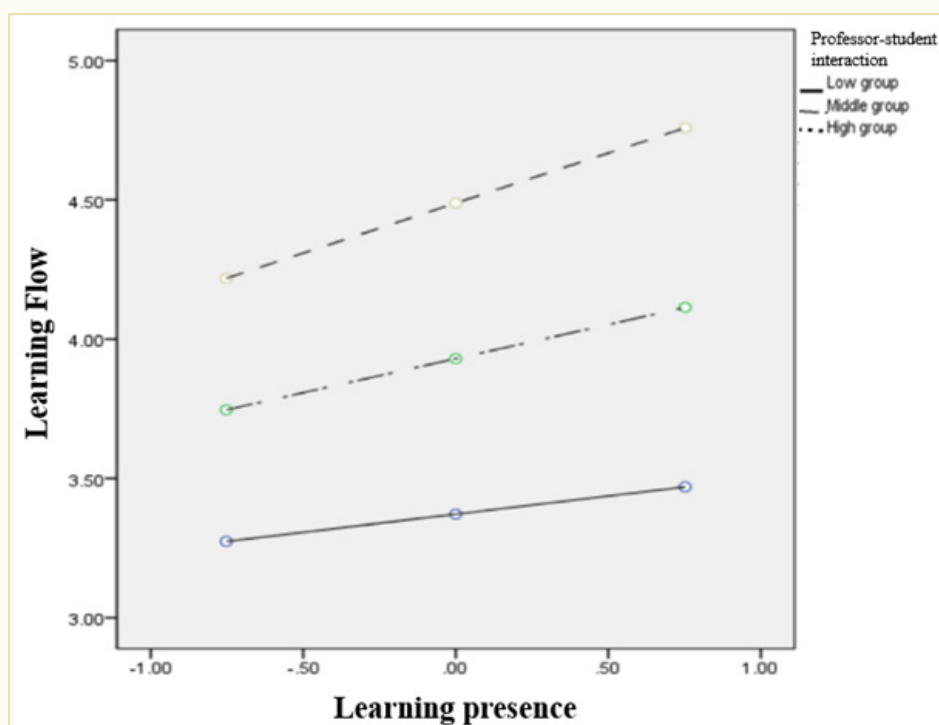


Figure 2 The moderating effect of Professor-student interaction on the relationship between learning flow and learning satisfaction

Table 2 presents the analysis results examining both the direct effect and conditional indirect effect of learning presence on learning satisfaction. The direct effect was estimated at .3275 (95% CI: .2284 to .4266), which is statistically significant since the confidence interval does not include 0. The conditional indirect effect was significant at middle and high levels of professor-student interaction,

with confidence intervals not including 0 (values ranging from -1.1161 to 1.1161, CI: .0844 to .3865). This supports the moderated mediating effect. However, the moderated mediation was not supported at low levels of professor-student interaction, where the conditional indirect effect was not significant. Additionally, the moderated mediating index was calculated as .0647 (95% CI: .0150 to .1166), which was statistically significant. This indicates that professor-student interaction moderates the effect of learning presence on learning satisfaction through learning flow. In conclusion, these findings support the moderated mediating effect of professor-student interaction on the pathway from learning presence to learning satisfaction.

Table 2

Direct effect and conditional effects of analysis

Direct effect (learning presence → learning satisfaction)					
Effect	se	t	p	BootLLCI*	BootULCI**
.3275	.0501	6.5345	.0000	.2284	.4266

Conditional indirect effects (learning presence → learning flow → learning satisfaction)				
Professor-student interaction	Effect	BootSE	BootLLCI*	BootULCI**
-1.1161	.0817	.0671	-.0447	.2176
.0000	.1539	.0668	.0302	.2912
1.1161	.2261	.0783	.0844	.3865

Index of moderated mediation				
Professor-student interaction	Index	BootSE	BootLLCI*	BootULCI**
	.0647	.0260	.0150	.1166

DISCUSSION AND CONCLUSION

This study explored the adoption of Metaverse-based practice classes by aviation service majors in universities, focusing on how these environments influence student behavior. The finding revealed four key relationships: First, learning presence was found to have a positive correlation with both learning flow and learning satisfaction. This aligns with existing literature, which consistently highlights the importance of learning presence in virtual environments. For instance, Lee's study [32] demonstrated that a strong learning presence within the Metaverse significantly enhances learning flow, as students become more engaged and absorbed in their tasks. Similarly, Shea, & Bidjerano [10] found that a robust learning presence fosters a conducive learning environment, which, in turn, leads to higher learning satisfaction. Furthermore, Jeong's research [13] emphasized that teaching presence and teacher-student interaction—key aspects of learning presence—significantly contribute to class satisfaction, with interaction showing a particularly strong influence.

Second, the study identified learning flow as a mediating factor in the relationship between learning presence and learning satisfaction. This mediation effect suggests that the benefits of learning presence on satisfaction are partly due to its role in enhancing learning flow. This finding is consistent with Cho, & Han's study [14], which revealed that perceived social presence, closely related to learning presence, significantly predicts learning satisfaction by increasing students' immersion and participation in online learning activities. Additionally, the research by Shea, and Bidjerano [10] and Jeong [13] further supports the idea that a strong learning presence, by fostering deep engagement, contributes to higher overall satisfaction.

Third, professor-student interaction moderated the relationship between learning presence and learning flow. Specifically, while the learning presence perceived by airline service major students increased their learning flow, the strength of this effect depended on the degree of professor-student interaction. Arbaugh [33] demonstrated that the community of inquiry framework effectively

predicts outcomes in online MBA courses, underscoring the importance of interaction and presence in educational success. For instance, Garrison, Anderson, & Archer [9] emphasized the role of critical inquiry and interaction in enhancing cognitive presence in online education. Thus, the degree of professor-student interaction is crucial in maximizing the positive effects of learning presence on learning flow among airline service major students. Professor-student interaction tends to be more impactful when it is consistent and meaningful, fostering a supportive learning environment where students feel engaged and motivated. This interaction not only enhances learning presence but also contributes to a deeper learning experience and improved educational outcomes.

Fourth, the moderated mediation effect of professor-student interaction was verified in the path from learning presence to learning satisfaction through learning flow. In other words, the indirect effect of learning presence on learning satisfaction via learning flow depends on professor-student interaction. Specifically, as degree of professor-student interaction increases, the positive effect of learning presence on learning flow gradually decreases. Professor-student interaction serves as a mechanism by which learning presence slows the positive path leading to learning satisfaction through learning flow.

The practical implications based on the research results presented here are very meaningful for future studies. From an academic perspective, previous studies mostly focused on the direct effects among metaverse' learning presence and learning satisfaction-related variables, and they individually identified the mediating or moderating effect on the link between related variables. By contrast, the present study used an integrated research model with the moderated mediation variable, and it can offer insights that can be applied to the educational context. From a practical perspective, Based on the findings that enhancing practical courses using metaverse technology can increase learning immersion and satisfaction among aviation service majors, with emphasis on the importance of professor-student interaction, several practical implications can be drawn.

In conclusion, promoting professor-student interaction within metaverse-based practical courses for aviation service majors not only enhances learning immersion and satisfaction but also provides comprehensive education for successful career preparation in the competitive aviation industry. This strategic approach ensures that students are well-equipped with both theoretical knowledge and practical skills, making them valuable assets to the aviation workforce. Additionally, fostering professor-student interaction within the metaverse environment allows for a more engaging and close-knit relationship, which increases students' interest in classes and enhances immersion through a sense of presence. This highlights the need to structure various courses that can benefit from these dynamics. Therefore, it is important to conduct detailed research on the factors affecting professor-student interaction and to develop capstone course-linked programs that facilitate professor-student interaction and enhance the learning flow and learning satisfaction derived from the metaverse's learning presence.

Despite these limitations, this study significantly contributes to the literature on Metaverse education. It provides valuable insights into how professor-student interaction moderates the relationship between learning presence, learning flow, and learning satisfaction among airline service major students in the Metaverse. Unlike previous studies that focused on direct effects, this research employs an integrated model with moderated mediation, offering practical insights for educational contexts. Overall, this study enhances our understanding of effective digital educational practices and highlights the importance of integrating new technologies into educational frameworks. It underscores the need to consider evolving educational practices when exploring innovations and technology adoption in Metaverse education.

Through this study, we deepen our understanding of effective educational practices in digital settings, offering critical insights for shaping future educational strategies and implementations. The research streamlines our comprehension of these theoretical interactions and offers a comprehensive perspective on factors shaping student behavior. Moreover, this study applies the Metaverse to the educational practices of aviation service major students, illuminating the importance of integrating new technologies into educational frameworks. This contribution underscores the significance of considering evolving educational practices when exploring innovations and technology adoption in Metaverse education.

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