FACTORS IMPACTING PUBLIC UNIVERSITY STUDENTS' SATISFACTION WITH THE CREATION AND EXHIBITION OF INTELLIGENT 3D ARTWORKS: A CASE STUDY OF ART EDUCATION IN A COLLEGE, CHENGDU, CHINA

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Received 31 May 2025
Revised 21 August 2025
Accepted 12 September 2025

Abstract

The researcher carried out a case study on the impact of art education at a university in Chengdu, China. The aim was to investigate the factors influencing student satisfaction with developing and presenting advanced 3D artwork at a public university. The study investigates the influence of seven independent variables (Perceived Benefits, Sense of Goal Achievement, Personalization, Two-Way Communication, Rewarding, Utilitarian, and Satisfaction) on a single dependent variable (Satisfaction). Additionally, it aims to identify significant differences between variables. The research met the Index of Item-Objective Congruence (IOC) criteria for validity and achieved a Cronbach's Alpha in a pilot test (n=30) for reliability. Four hundred valid student responses from a College of Science and Technology in Chengdu, China, were analyzed using multiple linear regression to assess the significance of relationships among variables. Subsequently, 30 students underwent a 12-week Intervention Design Implementation (IDI). Subsequently, the quantitative outcomes from the post-IDI and pre-IDI periods were compared using a paired-sample t-test. In multiple linear regression, the study revealed that behavior-focused, Sense of Goal Achievement, Personalization, Two-Way Communication, Rewarding, and Utilitarian. The above quantitative results showed significant effects, whereas Perceived Benefits did not have a significant impact on creativity. Additionally, the results from the paired-sample t-test for comparison demonstrated a significant difference in both Perceived Benefits and Rewards between the post-IDI and pre-IDI stages. The researcher conducted a comprehensive, in-depth case study on the profound influence of art education at a prestigious university in the vibrant city of Chengdu, China.

Keywords: Perceived Benefits, Rewarding, Utilitarian, Satisfaction, Intelligent 3D Artworks

Introduction

As science and technology continue to advance,3D has gained widespread popularity, creating new opportunities for the development of intelligent 3D art (Chen & Tsai, 2018). Consequently, scholars have focused on understanding the requirements and researching intelligent 3D art (Lam & So, 2013). In Chengdu, China's public universities have introduced courses and activities focused on producing and exhibiting intelligent 3D art (Van Braak et al., 2021). This paper delves into the various factors influencing students' satisfaction with creating and showcasing intelligent 3D art in public universities by examining background information related to technological advancements, evolving artistic demands, digital technology progress, and diverse applications of 3D art across different fields in its initial chapter (Yi, 1990).

From the perspective of technological innovation, intelligent 3D technology has made significant progress in the past decade (Chen & Lin, 2017). With the rapid development of computer graphics, artificial intelligence, and machine learning fields, 3D modeling, rendering, and interaction technologies have become increasingly mature (Mylonakis & Kendristakis, 2006). These technological innovations improve the efficiency and accuracy of creating 3D artworks and endow the works with richer visual effects and interactive experiences (Ozkan Bekiroglu et al., 2022). For example, through deep learning algorithms, artists can easily create complex scene modeling and material rendering, thus creating more realistic and captivating 3D artworks (Jobst & Boerner, 2011). These technological breakthroughs provide solid technical support for public universities to open intelligent 3D art creation and display courses (Segaran et al., 2021).

Literature Review

1. Satisfaction

Satisfaction is a consumer's emotional response to their experiences with a product or service (Spreng & Singh, 1993). In education, student satisfaction is influenced by the quality of teaching, the learning environment, and the student's personal experiences (Alsheyadi & Albalushi, 2020). Oliver (1981) suggests that satisfaction results from aligning expectations and actual outcomes. The concept of students as consumers has emerged, where students evaluate their education similarly to how consumers assess products (Blackmore, 2009). According to Arambewela and Hall (2006), student satisfaction is a "short-term attitude" shaped by evaluations of their educational experiences. Understanding satisfaction is crucial for improving the quality of education and student retention.

2. Perceived Benefits

Perception in psychology refers to the perception and knowledge of external things or stimuli through sensory organs (Downer et al., 2007). Perception involves processes at multiple levels, including sensation, perception, cognition, and emotion (Szolnoki & Perc, 2010).

Perception is the basis of human understanding of the world (Eiser et al., 2002). Through perception, we can obtain external information, understand the properties and relationships of things, and judge and make decisions (Jandyal et al., 2022). Various elements can influence perceptual capacity, such as physiological and psychological factors, social surroundings, and more (Zhou & Zhang, 2019). The field of perception has practical implications in various areas, including psychology, education, medicine, artificial intelligence, and beyond (Greene et al., 2004).

H1: Perceived benefits has a significant impact on students' satisfaction.

3. Sense of Goal Achievement

The sense of goal achievement refers to an emotional state of satisfaction, achievement, and self-affirmation experienced by an individual after achieving a predetermined goal or completing a task (Michon et al., 2017). This feeling stems from an individual's recognition and evaluation of the efforts they have made, the results they have achieved, and the difficulties they have overcome (Sun & Wang, 2017).

When individuals realize that their goals have been achieved, they are usually accompanied by positive emotional experiences, such as joy, pride, and satisfaction (Wang & Yuan, 2016). In conclusion, goal fulfillment is a complex and important concept involving multiple research and practice areas (Zhang & Liu, 2018). Through an in-depth understanding of its definition, influencing factors, and practical application, we can better understand and use this emotion and offer robust assistance for the advancement and progress of students (Chandel et al., 2016).

H2: Sense of goal achievement has a significant impact on students' satisfaction.

4. Personalization

Personalization is a concept that can be understood in different ways based on individual experiences and perspectives (Tong et al., 2023). For some, it represents tailoring to individuals; for others, it suggests an individualized approach to engaging with students or establishing a nurturing school environment (Kaura, 2013). For some, it also encompasses endeavors to personally, psychologically, and instructionally empower students (Hudson et al., 2016). The varied interpretations of personalization in recent decades have led to some ambiguity (Zhang & Xie, 2017). Nevertheless, we can offer a precise delineation of personalization if we aim for its pedagogy to expand and genuinely impact educational practice (Ellis & Bliuc, 2019).

H3: Personalization has a significant impact on students' satisfaction.

5. Two-Way Communication

Two-way communication refers to communication in which the positions of the sender and receiver of information constantly change; that is, information exchange is a two-way activity (Featherman & Pavlou, 2003). The characteristic of this communication method is that both parties can send and between two people are two-way communication (Gray & Diloreto,

2016). Two-way communication helps to obtain feedback information promptly (Chen & Wang, 2012). When implementing two-way communication, it is essential for all members of the organization, particularly leaders and public relations staff, to acknowledge the equal status of both parties in public relations and actively listen to each other's viewpoints during interactions (Khan & Javed Iqbal, 2016). Two-way communication facilitates timely feedback collection, enhances the accuracy of communication information, and strengthens the relationship between both parties (Zhu et al., 2014).

H4: Two-Way communication has a significant impact on students' satisfaction.

6. Rewarding

Reward serves as a tool for incentivizing individuals, inspiring a sense of pride and entrepreneurial drive, activating the enthusiasm of administrative staff and management counterparts, and maximizing their potential (Benjamin & Jennings, 2010). This encompasses tangible rewards like bonuses, prizes, salary increments, etc., and intangible ones (Zhang, 2021), such as praise, credit, and assistance (Chang et al., 2004). At the same time, in social life, feedback information such as understanding, trust, and respect for people, affirmation. Support, and help for work, etc., can be called rewards if they can bring joy to people and consolidate and stimulate positive behaviors (Cronin et al., 2000).

H5: Rewarding has a significant impact on students' satisfaction.

7. Utilitarian

Utilitarianism is an ethical doctrine grounded in practical utility or benefit, emphasizing the outcomes of actions and striving for the maximum happiness for the largest number of people (Ratri & Wahjudono, 2021).

It is a significant theory guiding moral and ethical decision-making (Prenshaw et al., 2006). Realism is a concept centered on practical interests and utilitarianism, and its specific meaning and application depend on the field and context (Phillips & Baumgartner, 2002). In education, materialism emphasizes practicality, utility, and actual benefits. In business and economic activities, materialism pays more attention to the pursuit of economic interests and profit maximization (Locke, 1976).

H6: Utilitarian has a significant impact on students' satisfaction.

Research Framework

The author introduces this paper's research design and method and discusses the significance of Students at a college in Sichuan province's improvement in art aesthetic education, learning content interaction, and learning interaction with students. Action and perception participation in Sichuan University education helps them learn to solve this problem and improve student satisfaction. To better study this topic, the authors used quantitative research methods and an intervention design and implementation model (IDI).

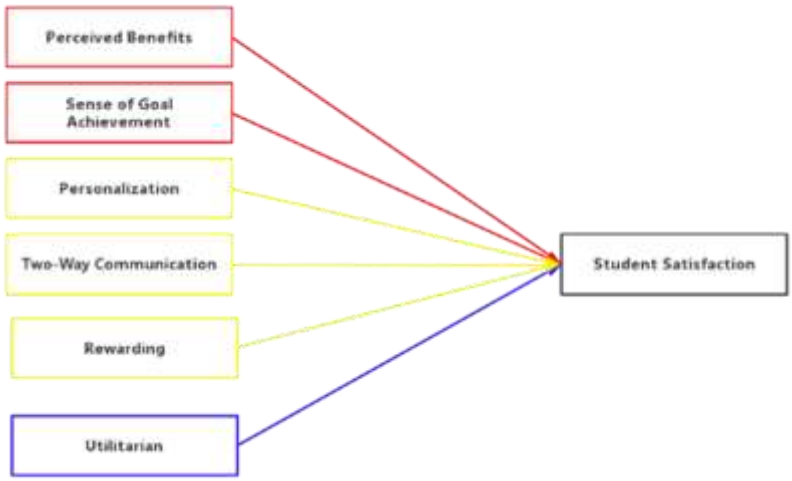


Figure 1 Conceptual Framework

The hypotheses of the research variables based on the conceptual framework are;

H1: Perceived benefits has a significant impact on students' satisfaction.

H2: Sense of goal achievement has a significant impact on students' satisfaction.

H3: Personalization has a significant impact on students' satisfaction.

H4: Two-Way communication has a significant impact on students' satisfaction.

H5: Rewarding has a significant impact on students' satisfaction.

H6: Utilitarian has a significant impact on students' satisfaction.

Research Methodology

The research procedure encompasses four distinct phases. Initially, a survey was conducted on the entire research cohort (n=400) to gather data for the proposed conceptual framework. Subsequently, all hypotheses underwent strict multiple linear regression testing to determine their significance at a threshold of <0.05. Thus, upheld hypotheses were retained, while those that failed to meet the criterion were eliminated. The second phase entailed conducting a pre-IDI survey among 90 students within the purview of the supported hypotheses.

Research Population, Sample Size, and Sampling Procedures

1. Research Population

In this study, the researchers carefully selected 400 students from Chengdu Aeronautic Polytechnic College as the sample group for the pre-survey. This selection was not random but based on carefully considering the overall student population size and scientific sampling. According to the latest data published on the official website of Chengdu Aeronautic Polytechnic College, the total number of students is approximately 13,000, a relatively large and diverse learning community.

2. Sample size

In this study, the researchers ensured the scientific and effectiveness of the entire research design. They selected 30 students as the subjects of the pilot survey, which not only helped the researchers initially understand the validity and reliability of the questionnaire but also provided valuable practical experience for their subsequent large-scale survey. Through the pilot test, the researchers made necessary adjustments and optimizations to the questionnaire content to ensure that it could accurately and comprehensively collect the required data information.

3. Sampling Procedures

The researcher carried out several sampling processes, and the related procedures were as follows:

Sampling 1: Sampling for the pilot survey and pilot test

The researcher randomly selected 30 students and asked them to complete the survey questionnaire and provide feedback for the pilot survey and pilot test.

Sampling 2: Sampling for the Pre-survey

The researcher selected 450 students from different years at Chengdu Aeronautic Polytechnic College for the pre-survey by distributing the questionnaire on printed paper. Subsequently, the researcher examined all the responses and confirmed that 400 of them were valid.

Sampling 3: Sampling for intervention design and implementation model (IDI)

Research Instruments

1. Design of Questionnaire

The researcher developed the questionnaire in three steps.

Step 1: A literature review was conducted to select relevant academic sources and define the questionnaire content.

Step 2: The questionnaire was designed and refined. Questions were adjusted based on research objectives and hypotheses. Wording and order were modified for clarity and logic. Some questions were added or removed as needed.

Step 3: A pilot survey was conducted. Feedback was used to revise the questionnaire based on IOC.

2. Components of Questionnaire

The items of the survey questionnaire were constituted through the following three parts:

Part 1: Screening Questions. There were screening questions to filter out the non-research population.

Part 2: Basic Info Questions. Questions were asked to obtain basic information about the research population, such as gender, age, birthplace, and so forth.

Part 3: Pre-survey Questions. There were questions for the pre-survey to determine the current level of IV and DV among 410 students at Chengdu Aeronautic Polytechnic College.

3. IOC Results

The specific scoring criteria are as follows: +1 indicates that the item is highly relevant to the target and is an essential part of the questionnaire, zero means that the item has some questionable aspects that may need further clarification or modification, and -1 indicates that the item is not relevant to the research topic and should be removed. After a rigorous evaluation by the three 3D printing art experts, the researchers were pleased to find that all items in the questionnaire received a score of at least 0.67.

4. Pilot survey and Pilot test results

The researcher conducted a pilot survey among 30 randomly selected students by asking them to fill in the survey questionnaire and provide feedback. Subsequently, the researcher carried out Cronbach's Alpha's internal consistency reliability test, which should be equal to or greater than 0.7. Thus, the table below demonstrates the approved results for the high reliability of each construct.

Table 1: Pilot Test Result

Variables	No. of items	Sources of Questionnaire	Cronbach's Alpha	Strength of association
Perceived Benefits	5	Wu (2016)	0.983	Excellent
Sense of Goal Achievement	4	Neubert and Wang (2007)	0.953	Excellent
Personalization	5	Azevedo (2015)	0.966	Excellent
Two-Way Communication	5	Fishbein and Ajzen (1977)	0.984	Excellent
Rewarding	4	Weavis (1979)	0.984	Excellent
Utilitarian	4	Kaven (1967)	0.965	Excellent
Satisfaction	4	Thong and Hao (2017)	0.952	Excellent

Results and Discussion

1. Demographic Information

This section presents the data in frequency and percentage, with participants selected from one of the author's classes. The specifics are as follows: As shown in Table 2, 90 students participated in the study. Twenty respondents (22%) were female, and 70 respondents (78%) were male. The results showed that male respondents represented most of the class.

Table 2: Demographic Profile

Entire Research Population (n=90)		**Frequency**	**Valid Percent**
Gender	Male	70	78%
	Female	20	22%
Total		**90**	**100%**
SP Participants (n=30)		**Frequency**	**Valid Percent**
Gender	Male	10	33.3%
	Female	20	66.7%
Total		**30**	**100%**

2. Results of multiple linear regression

A researcher conducted a comprehensive multiple linear regression (MLR) analysis on a dataset comprising 400 survey questionnaire results. The primary objective was to ascertain the validity of each research hypothesis formulated. The study encompassed six research hypotheses, focusing on five hypotheses specifically related to Dependent Variable Satisfaction. Upon examining the results, it was reassuring to conclude that multicollinearity was not a pressing concern.

Table 3: The multiple linear regression of five independent variables on teacher' job satisfaction

Variables	**Standardized Coefficients Beta**	**t**	**P-value**	**R**	**R Square**
Perceived Benefits (PB)	0.6163	11.177	< .001 *		
Sense of Goal Achievement (SGA)	0.2060	3.352	< .001 *		
Personalization (Per)	0.0195	0.276	0.783	0.852	0.726
Two-Way Communication (TC)	-0.1513	-2.116	0.035*		
Rewarding (Rew)	0.1279	2.004	0.046*		
Utilitarian (Uti)	0.0711	1.247	0.213*		

Dependent variable: satisfaction

Note: p-value <0.05*

The final intervention design and implementation model hypothesis were related to changes before and after IDI, and this study's study hypothesis was tested and supported by the results of multiple linear regression (MLR). According to the MLR results, Personalization and Utilitarian had no significant effect on students' Satisfaction, and the following is the final study hypothesis regarding the change in each variable between Pre-IDI and Post-IDI:

H7: There is a significant mean difference in Perceived Benefits Pre-IDI and Post-IDI.

H8: There is a significant mean difference in Sense of Goal Achievement Pre-IDI and Post-IDI.

H9: There is a significant mean difference between two-way communication pre-IDI and post-IDI.

H10: There is a significant mean difference between Rewarding Pre-IDI and Post-IDI.

H11: There is a significant mean difference in satisfaction pre-IDI and post-IDI.

3. IDI Intervention Stage

This study aims to recognize the elements that influence Sichuan University students' satisfaction with three-dimensional artworks and exhibitions. According to the results of MLR, it mainly discusses the intervention process between student satisfaction, the detailed design of the intervention design and implementation (IDI) process for 12 weeks, the intervention design and implementation (IDI) process includes information about the time and place, the personnel involved, the goals and tools of the intervention design and implementation (IDI) process, and the specific activities conducted at this stage. as illustrated in Table 4

Table 4: Implementation time and activities as a Strategic Planning

No.	Time and Duration	Implementation keywords
1	Week 1	Start the lecture Introduce the research purpose, expected results, and stimulate students' interest in three-dimensional art.
2	Week 2-4	Lecture on 3D art foundation and appreciation An art critic, professional teacher or artist is invited to give weekly special lectures on art history, art genre, and the skills and appreciation of 3D art.
3	Week 5-6	Appreciation and creation of art works Organize students to conduct on-site teaching, appreciate the classic three-dimensional art works, and conduct on-site discussion.

Table 4 (Continue)

No.	Time and Duration	Implementation keywords
4	Week 7-8	Collaborative exploration and showcase Students form teams to analyze and explore a selected three-dimensional art piece in depth, presenting their findings and insights during class discussions.
5	Week 9-10	Exhibition planning Students curate a small 3D exhibition of art works in small groups. This includes selecting works of art, designing the layout of the exhibition, and writing exhibition copywriting.
6	Week 11	Exhibition layout and preparation According to the planning plan, the students will arrange the exhibition in the designated exhibition space, including hanging 3D works, arranging the exhibition space, etc.
7	Week 12	The exhibition is officially open to the public, inviting teachers, students and art lovers from both inside and outside the school to visit. Collect visitor feedback, and students' self-reflection, to provide improvements for future 3D art education and exhibition is open with feedback.

4. Results Comparison between Pre-IDI and Post- IDI

To assess the impact of the intervention design and implementation (IDI), researchers conducted paired sample t-tests on six key variables, comparing pre- and post-intervention scores. This statistical approach was used to determine whether the intervention induced significant changes. Findings from these analyses will be presented in the following table, which details the results of each t-test, indicating statistical significance and thereby confirming the intervention's efficacy:

Table 6: Paired-Sample t-test Results

Variables	Mean	SD	t-value	P-Value
Satisfaction				
Pre-IDI	3.85	0.724	-4.66	<.001
Post-IDI	4.34	0.719		
Perceived Benefits				
Pre-IDI	4.00	0.647	-3.16	0.002
Post-IDI	4.32	0.703		
Sense of Goal Achievement				
Pre-IDI	3.89	0.661	-3.46	<.001
Post-IDI	4.25	0.712		
Personalization				
Pre-IDI	3.99	0.641	-2.76	0.007
Post-IDI	4.28	0.698		
Two-Way Communication				
Pre-IDI	3.90	0.677	-3.63	< .001
Post-IDI	4.28	0.703		
Rewarding				
Pre-IDI	3.89	0.717	-3.34	0.001
Post-IDI	4.27	0.735		
Utilitarian				
Pre-IDI	3.84	0.724	-3.74	< .001
Post-IDI	4.25	0.746		

Table 6 the results of the paired-sample t-test analysis of pre-IDI and post-IDI comparison as follows:

According to the above table:

There was a significant difference in Satisfaction between pre-IDI (M=3.84, SD=0.724) and post-IDI (M=4.34, SD=0.719) conditions; t (89) =-4,66, p < .001 and the mean difference was -0.489.

There was a significant difference in Perceived Benefits between pre-IDI (M=4.00, SD=0.647) and post-IDI (M=4.32, SD=0.703) condition; t (89) =-3.16, p =0.002 (<0.05) and the mean difference was -0.324.

There was a significant difference in Sense of Goal Achievement between pre-IDI (M=3.89, SD=0.661) and post-IDI (M=4.25, SD=0.712) condition; t (89) =-3.46, p < .001and the mean difference was -0.364.

There was a significant difference in Personalization between the pre-IDI (M=3.99, SD=0.641) and post-IDI (M=4.28, SD=0.698) conditions; t (89) =-2.76, p =0.007, and the mean difference was—-0.291.

There was a significant difference in Two-Way Communication between pre-IDI (M=3.90, SD=0.677) and post-IDI (M=4.28, SD=0.703) conditions; t (89) =-3.63, p<0.001 and the mean difference was -0.387.

There was a significant difference in Rewarding between pre-IDI (M=3.89, SD=0.717) and post-IDI (M=4.27, SD=0.735) conditions; t (89) =-3.34, p0.001 and the mean difference was -0.387.

There was a significant difference in Utilitarian between pre-IDI (M=3.84, SD=0.724) and post-IDI (M=4.25, SD=0.746) condition; t (89) =-3.74, p< .001 and the mean difference was -0.411.

Discussions, Recommendations, Limitations and Future Research

1. Discussions

This study examined the effects of six independent variables—perceived Benefits, Sense of Goal Achievement, Personalization, Two-Way Communication, Rewarding, and Utility—on Student Satisfaction.

The research followed three phases: pre-IDI, IDI, and post-IDI.

In the pre-IDI phase, the researcher reviewed the literature, selected variables from Smith (1992) and Williams (1998) and developed a conceptual framework. Qualitative and quantitative data were collected.

A questionnaire was created and tested for validity using IOC scores from three experts. To check reliability, a pilot test with 30 students was conducted using Jamovi. Then, 400 students were randomly selected to complete the questionnaire. Multiple linear regression (MLR) was used to test the hypotheses.

MLR results showed that five variables (Perceived Benefits, Goal Achievement, Two-Way Communication, and Rewarding) significantly affected Satisfaction. Utilitarianism did not, so it was excluded from the intervention model.

In the IDI phase, 30 students from the Architecture and Civil Engineering program participated in the intervention. Activities were based on Gagne's learning outcome theory and focused on Perceived Benefits and Rewards. These included 3D puzzle contests, VR challenges, and DIY workshops to boost engagement and Satisfaction.

In the post-IDI phase, a paired sample t-test was conducted. The results showed significant improvements in all six variables, indicating effective intervention.

In conclusion, this study spanned 1.5 years and combined theory with practice. Despite challenges, the process offered valuable insights into education and student engagement.

2. Recommendations

Based on this study's findings, perceived benefits can significantly enhance students' engagement. Therefore, the following specific recommendations are proposed from five different aspects to optimize the 3D art printing teaching process further and enhance students' sense of participation and learning effect.

Showcase Technological Charisma: Regularly hold 3D printing works exhibitions and technology demonstrations to give students a direct and tangible experience of the creativity and practicality of 3D printing technology, enhancing their interest and identification with the technology.

Emphasize Practical Applications: Combine real-life cases, such as customized gifts, architectural models, and biomedical applications, to demonstrate the wide application of 3D printing technology and enhance students' recognition of its value.

Innovate Course Design: Design comprehensive courses that include basic theory, practical operation, and creative design based on students' learning needs and interests to ensure rich and engaging content. Promote Teacher-Student Interaction: Adopt interactive teaching methods such as group discussions and project collaborations to encourage student participation, and teachers should provide timely feedback and guidance to enhance communication and cooperation between teachers and students.

Finally, this study primarily focused on exploring the impact of specific student groups' participation. It analyzed the roles of key factors such as perceived benefits, goal achievement, personalization, two-way communication, rewards, and utilitarianism. However, while this research perspective is in-depth and specific, it also has limitations. While it provides a valuable perspective for understanding the impact on student participation, many areas are still worth further exploration and improvement.

3. Limitations and Future Research

Although this study examined the impact of six independent variables on satisfaction, it has some limitations. Future research can explore the following aspects further. The factors affecting the satisfaction of public university students with intelligent three-dimensional art creation and exhibition are multifaceted. Future research can further expand the sample range, explore more independent variables, adopt more objective research methods, and pay attention to the dynamic development of technology to better understand the current situation and future trends in this field.

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