

Students' Creative Learning Engagement with AI Painting Tools: A Technology Acceptance and Learning Experience Perspective

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ABSTRACT With the increasing application of generative AI in art and design education, AI painting tools have become integrated into the idea development, visual experimentation, and image-making behavior of students. Nevertheless, studies have seldom investigated the impact of such a tool on the participation in creative learning. Based on technology acceptance and learning experience points of view, the presented paper explores how perceived usefulness, perceived ease of use, perceived creative control and teacher support influence creative learning engagement with flow experience and learning satisfaction acting as mediators. Questionnaire survey was administered to university students who have used AI painting tools and 382 respondents were obtained. Structural equation modeling was used to analyze the data. The results show that perceived usefulness, perceived ease of use, and perceived creative control positively influence flow experience. Learning satisfaction is also enhanced by perceived usefulness, perceived ease of use, perceived creative control, teacher support and flow experience. In addition, flow experience and learning satisfaction are associated with higher levels of creative learning engagement and learning satisfaction has the most direct effect. Such findings underline the importance of student agency, positive learning experience, and pedagogical support in AI-assisted creative learning.

INDEX TERMS AI painting tools; creative learning engagement; flow experience; learning satisfaction; perceived creative control

I. INTRODUCTION

The use of AI painting tools has gained popularity in the visual arts, design practice, and artistic education. As opposed to traditional digital painting programs, which normally rely on the ability of users to draw and their technical skill, AI painting tools enable users to create and edit visual images by providing them with instructions, stylistic options and through repeated modification [1]. The change has minimized the technical challenges of creating an image and has offered students other avenues to come up with ideas, examine the visual possibilities, and communicate their artistic ideas. Consequently, these tools are not restricted to image production in art and design education but are slowly being adopted to facilitate creative thinking, experimentation, and human-AI collaboration [2]. To students, the educational value of AI painting tools is not only in the visual beauty of the created images, but also in the fact that these tools affect their perception of creation, involvement in learning processes, and assurance in visual expression [3].

Students usually have to convert the abstract ideas into prompts when working on coursework or design projects with AI painting tools, compare different outputs, modify the visual styles, and decide if the produced results correspond to the intended concepts. Such activities might prompt students to participate in creative exploration actively. At the same time, the use of AI painting tools leads to certain concerns [4]. There can be cases when learners depend excessively on the produced images and diminish their own thinking and fundamental training, whereas others may believe that AI restricts their mastery of the creative process [5]. Thus, it is important to explore the manner in which student perceptions of AI painting tools and their learning experience impact their creative learning engagement.

Creative learning engagement in this research means that students are cognitively, emotionally and behaviorally engaged in creative learning tasks. Concerning the AI painting tools, it does not imply merely the fact of using the tools, but whether the students actively seek various visual answers, polish the prompts, contrast the outcomes produced by

the tools, think about the creative process, and utilize AI-assisted outputs to undertake course projects or design tasks. Creative learning engagement is a more suitable measure of the extent to which students participate in AI-assisted art and design learning than general technology use intention. With the growing popularity of generative AI in higher education, the understanding of student engagement with these tools in the educational environment is becoming even more crucial [6]. Other studies have addressed the topic of AI tools based on ideas including technology acceptance, system quality, use intention, generative AI applications in higher education [7], [8]. Nevertheless, the concept of creative learning engagement in the particular case of AI painting tools has received little focus. In particular, it is still unknown what combination of perceived creative control, teacher support, flow experience and learning satisfaction can be attributed to students engaging in AI-assisted creative learning.

To fill this gap, this paper suggests the use of a structural equation model that is founded on the concept of technology acceptance and learning experience. The study investigates the relationship between perceived usefulness, perceived ease of use, perceived creative control and teacher support on flow experience, learning satisfaction and creative learning engagement. This research in particular answers three questions: Firstly, what are the effects of student technology perceptions and perceived creative control on flow experience and learning satisfaction as students engage in AI painting tools? Secondly, how does teacher support contribute to student satisfaction related to AI-assisted creative learning? Thirdly, how can flow experience and learning satisfaction further enhance creative learning engagement? Through addressing these questions, this research turns attention away to the overall intention of technology use to creative learning engagement among students and offers an educational explanation of AI painting tools in art and design learning. These results can also be useful to teachers and institutions trying to incorporate AI painting tools into creative education in a more efficient and student-focused manner.

II. LITERATURE REVIEW AND RESEARCH HYPOTHESES

A. AI PAINTING TOOLS AND STUDENTS' CREATIVE LEARNING

AI painting tools are the creation tools on the basis of machine learning, deep learning and generative AI technologies which can create a visual image automatically using the text prompt, image reference, or style parameters given by users. In comparison to conventional painting software, AI painting tools do not require as much reliance on hand-drawing abilities and sophisticated software use, which allows users to achieve creative ideation, image generation, style exploration and visual representation by working in partnership with AI. This technological shift has not affected just the visualization process, but also

the educational materials, teaching methods, and creative approaches to art and design education.

The use of AI painting tools in a student creative learning environment may reduce the barrier to visual expression, give various styles of expression, and give immediate visual feedback. Such features enable students to convert abstract concepts into visual pictures, evaluate various creative alternatives, and take a more active role in prompt creation, image choice, solution optimization, and assessment of work [9]. Nevertheless, there are some concerns with their educational use as well, including excessive reliance on AI-generated results by students, reduced original thinking, and poor knowledge of the mechanism underlying image generation. Consequently, the value of AI painting tools in art and design education is not just whether they could produce images or not, but whether they would be able to encourage creative learning engagement among students.

This paper uses the term creative learning engagement to mean students being involved in the creative activities that are supported by AI such as exploring creative directions, refining prompts, comparing the results produced, and using AI-produced materials to learn in class or practice in design. The analysis of this construct will shed more light on whether AI painting tools can enhance participation in the learning process or simply help in producing images.

B. TECHNOLOGY ACCEPTANCE MODEL, PERCEIVED USEFULNESS, AND PERCEIVED EASE OF USE

Technology Acceptance Model is a significant underpinning in understanding how users perceive and adopt digital technologies. Perceived usefulness and perceived ease of use are considered as two main determinants of technology acceptance in this model [10]. The two constructs have been used here in the context of AI painting tools in creative learning.

Perceived usefulness is a term used to describe students beliefs in the fact that AI painting tools can enhance their creative learning performance, e.g., increase creative efficiency, facilitate visual ideation, and enhance the quality of their course assignments or design works. Students are more prone to developing positive learning experiences when they feel that these tools are useful in achieving creative work. Perceived ease of use is the notion of students believing that AI painting tools are easy to comprehend, use, and apply to educational tasks. In case students could use the tool with ease and change the outcome with no additional efforts, there is a possibility that they would remain engaged and happy throughout the entire creative process. Considering this, the given hypotheses are suggested:

H1: Perceived usefulness positively influences students' flow experience when using AI painting tools.

H2: Perceived ease of use is a positive predictor of student flow experience in the use of AI painting tools.

H3: Perceived usefulness positively influences students' learning satisfaction when using AI painting tools.

H4: The perceived ease of use is an antecedent to the learning satisfaction of students when they use AI painting tools.

C. PERCEIVED CREATIVE CONTROL

Perceived creative control can be defined as the subjective feeling of students about their own power to steer the creative path, image design, outputs, and artistic performance on the use of AI painting applications. Even though AI painting application could create an image automatically, it does not imply that students do not have their own choice in the creative process. The students should direct AI-generated content by giving prompts to input, style, parameters, image selection and result editing until the resulting output resembles their intentions [11]. Consequently, perceived creative control is a significant variable that differentiates AI painting tools and regular learning software.

When students feel that they have a chance to shape the generation process and bring its outcomes nearer to their personal views, they are more likely to develop their creative agency. This feeling of control might increase their engagement in creative activities and motivate them to explore again. It can also assist students in achieving a concentrated and absorptive mind, as they view AI painting tools as not replacing their creation, but as an aid to their creative expression. On this basis the following hypotheses have been put forward:

H5: Perceived creative control positively influences students' flow experience when using AI painting tools.

H6: Perceived creative control positively influences students' learning satisfaction when using AI painting tools.

D. TEACHER SUPPORT

Support of teachers involves the guidance, feedback, and normative help offered by teachers as students are using AI painting tools to learn and create. The use of AI-created works in art and design classes may be related to course activities, teaching in the classroom, and assessment of work. Teachers are thus still significant in assisting students to make proper and effective use of AI painting tools [12].

The teacher support may consist of explaining the roles and limits of AI painting software, assisting students with prompt development and assessment of the images, and encouraging them to think about originality, copyright, and ethical considerations. This kind of support can help mitigate the ambiguity of students when it comes to the use of AI tools and enhance the favorable assessment of the education process. In turn, the following hypothesis will be suggested:

H7: Teacher support positively influences students' learning satisfaction when using AI painting tools.

E. FLOW EXPERIENCE AND LEARNING SATISFACTION

Flow experience is the state of intense absorption and involvement where people derive pleasure on the activity being done [5]. Flow can be experienced by students in

AI-supported creative learning as they are engaged in the process of image creation, comparison of various visual results, and iterative refinement of their creative responses. The immediate feedback of AI painting software might also enhance such an immersive feeling.

Learning satisfaction refers to the general opinion of students about the learning process, learning aids, and learning results. In terms of AI painting software, satisfaction is not only determined by how high-quality the images produced are, but also by whether or not the software allows students to finish creative work and gain good learning experiences. Students who have the experience of concentration, fun and accomplishment in AI assisted creation are likely to create a positive perception of the learning process. On this foundation, the given hypothesis is offered:

H8: Flow experience positively influences students' learning satisfaction when using AI painting tools.

F. CREATIVE LEARNING ENGAGEMENT

The result variable of this research is creative learning engagement which means the prolonged engagement of the students, their active exploration, and high participation in AI-based creative learning [13]. It contains behavioral engagement, including the active use of tools and modification of works; cognitive engagement, including the analysis of the outcomes produced and the reflection upon the creative logic; and emotional engagement, including the maintenance of interest along with the feeling of achievement in the course of creative work. Creative learning engagement is a more appropriate indicator of the educational value of AI painting tools than general use intention.

When AI painting tools are used, flow experience can boost student interest and engagement as well as encourage them to engage in further visual exploration and optimization of solutions. The notion of learning satisfaction is also significant since students have the tendency to put much effort into the work if they think that AI painting tools will satisfy learning requirements, promote creative productivity, and provide a positive learning experience. These hypotheses have been suggested on this basis:

H9: Flow experience positively influences students' creative learning engagement when using AI painting tools.

H10: Learning satisfaction positively influences students' creative learning engagement when using AI painting tools.

III. RESEARCH METHODS AND DATA ANALYSIS RESULTS

A. QUESTIONNAIRE DESIGN

The online questionnaire was created so as to explore the perceptions and learning experiences of the university students concerning AI painting tools. Eligible respondents were those students who had already used AI painting tools. The questionnaire consisted of two parts. The first part gathered general data, i.e., gender, age group, educational level, academic background, and experience with AI painting tools. The second part evaluated the major constructs

of the research model, which are perceived usefulness, perceived ease of use, perceived creative control, teacher support, flow experience, learning satisfaction, and creative learning engagement. Items of measurement were based on existing scales but adjusted to the situation of AI-assisted creative learning. Prior to the official survey, a number of students who have used AI painting tools before were asked to look through the questionnaire. The ultimate items and their sources are given in Table 1.

B. DATA COLLECTION AND SAMPLE

The questionnaire was made available online to university students. The first question of the survey served as a screening question that asked if the respondents have ever used an AI painting application. The responses of those who did not have any relevant experience were discarded. They collected a total of 400 questionnaires. Following elimination of non-useful responses, including those with unusually short completion times, patterned responses, or repeated choice of the same option, 382 useful responses remained to be analyzed. Structural equation modelling was adequate to handle the sample size and it could be appropriately employed in studying student creative learning engagement in the context of using AI painting tools.

C. MEASUREMENT MODEL ASSESSMENT

The results of reliability and convergent validity are shown in Table 2. All the factor loadings were greater than the suggested level of 0.70, and all the values of Cronbachs Alpha, rho A, and composite reliability were greater than 0.70. Also, the mean value of variance extracted was greater than 0.50. Such findings suggest that the measurement model had high internal consistency and good convergent validity.

The measure of discriminant validity was done through the use of the Fornell-Larcker criteria and HTMT values. It is evident in Table 3 that the square root of AVE of every construct has a larger value than the correlation between the same construct and other constructs.

Table 4 shows HTMT results lower than the acceptable level of 0.85. The constructs thus had adequate levels of discriminant validity and the measurement model could be used to carry out the subsequent structural analysis.

D. HYPOTHESIS TESTING

The structural model was then tested with the reliability and validity of the measurement model being established. The findings are presented in Table 5 and Fig. 1. Both perceived usefulness and perceived ease of use had positive effect on flow experience and learning satisfaction. Namely, perceived usefulness had a significant impact on flow experience ($\beta = 0.179$, $p = 0.006$) and learning satisfaction ($\beta = 0.227$, $p = 0.001$). Perceived ease of use also had a significant impact on flow experience ($\beta = 0.247$, $p < 0.001$) and learning satisfaction ($\beta = 0.128$, $p = 0.008$). Therefore, H1, H2, H3, and H4 were confirmed. Perceived creative

control had highly significant positive effects on flow experience ($\beta = 0.301$, $p < 0.001$) and learning satisfaction ($\beta = 0.163$, $p = 0.012$), which supports H5 and H6. Teacher support also had a significant effect on learning satisfaction ($\beta = 0.194$, $p < 0.001$), which supports H7. Flow experience also had a significant effect on learning satisfaction ($\beta = 0.138$, $p = 0.023$), which supports H8. Also, flow experience ($\beta = 0.294$, $p < 0.001$) and learning satisfaction ($\beta = 0.416$, $p < 0.001$) were positively related to creative learning engagement, which supports H9 and H10. On the whole, perceived creative control turned out to be the most powerful antecedent of flow experience, whereas learning satisfaction proved to be the most powerful predictor of creative learning engagement.

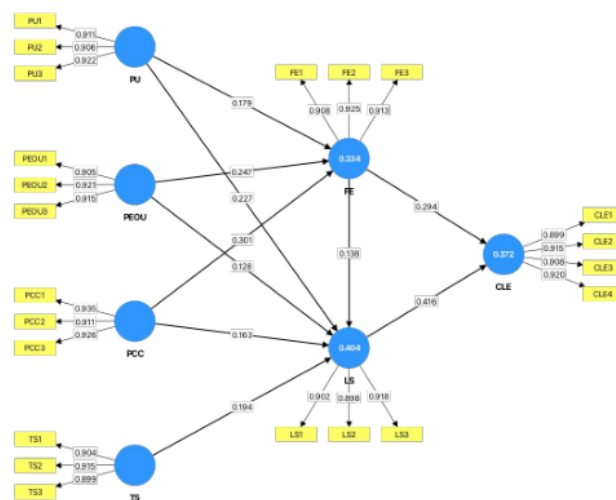


FIGURE 1. Model Estimation Results

TABLE 5. Summary of Hypotheses Tests

H	Relationship	β	T-value	P	2.50%	97.50%	Supported
H1	PU → FE	0.179	2.774	0.006	0.052	0.306	Yes
H2	PEOU → FE	0.247	4.249	0.000	0.136	0.363	Yes
H3	PU → LS	0.227	3.412	0.001	0.098	0.362	Yes
H4	PEOU → LS	0.128	2.656	0.008	0.032	0.224	Yes
H5	PCC → FE	0.301	5.002	0.000	0.186	0.418	Yes
H6	PCC → LS	0.163	2.516	0.012	0.040	0.294	Yes
H7	TS → LS	0.194	3.785	0.000	0.093	0.297	Yes
H8	FE → LS	0.138	2.277	0.023	0.016	0.257	Yes
H9	FE → CLE	0.294	4.825	0.000	0.174	0.413	Yes
H10	LS → CLE	0.416	6.923	0.000	0.297	0.535	Yes

IV. DISCUSSION

The research focused on the creative learning participation of students in AI painting tools based on the point of view of technology acceptance and learning experience. The results indicate that the educational quality of AI painting tools does not depend solely on their ability to generate images, but on how students evaluate them as useful, controllable, and meaningful in the context of creative learning activities. During this procedure, flow experience and learning satisfaction act as significant psychological factors that can make

TABLE 1. Questionnaire Items

Variables	Items	Ref.
Perceived Usefulness	1. I believe that AI painting tools can improve my creative learning efficiency. 2. AI painting tools can help me form visual ideas more quickly. 3. AI painting tools help improve the quality of my course assignments or design works.	[14]
Perceived Ease of Use	1. I think the operation of AI painting tools is relatively easy to understand. 2. I can quickly master the basic methods of using AI painting tools. 3. I think AI painting tools can be easily applied to my learning tasks.	[14]
Perceived Creative Control	1. When I use AI painting tools, I can also manage the creative direction of my work very well. 2. Through changing prompts or parameters, I am able to make the produced results more similar to my creative thoughts. 3. I think that I am still very much motivated in the AI-assisted creative process.	[15]
Teacher Support	1. Teachers guide us on how to use AI painting tools reasonably. 2. Teachers help us analyze and evaluate the advantages and disadvantages of AI-generated images. 3. Teachers warn us to be careful with originality, copyright, or ethical problems with AI-produced artworks.	[16]
Flow Experience	1. When creating with AI painting tools, I can easily enter a focused state. 2. I start developing an interest in the process of image generation and adjustment when I use AI painting tools. 3. When creating with AI painting tools, I often feel that time passes quickly.	[17]
Learning Satisfaction	1. AI painting tools can better meet my creative learning needs. 2. I believe that it is a positive learning experience to use AI painting tools in terms of creative learning. 3. Overall, I am satisfied with my experience of AI-assisted creative learning.	[18]
Creative Learning Engagement	1. I am willing to actively use AI painting tools to explore different creative solutions. 2. I am willing to invest time in optimizing prompts and adjusting generated results. 3. I carefully compare and analyze the effects of AI-generated images. 4. I am ready to continue editing the material produced by AI painting applications and use it as a tool of education.	[19]

TABLE 2. Reliability and Validity Analysis

Variables	Items	Factor Loading	CA	Rho(A)	CR	AVE
CLE	CLE1	0.899	0.931	0.932	0.951	0.829
	CLE2	0.915				
	CLE3	0.908				
	CLE4	0.920				
FE	FE1	0.908	0.903	0.905	0.939	0.838
	FE2	0.925				
	FE3	0.913				
LS	LS1	0.902	0.891	0.897	0.932	0.821
	LS2	0.898				
	LS3	0.918				
PCC	PCC1	0.935	0.914	0.915	0.946	0.854
	PCC2	0.911				
	PCC3	0.926				
PEOU	PEOU1	0.905	0.901	0.904	0.938	0.835
	PEOU2	0.921				
	PEOU3	0.915				
PU	PU1	0.911	0.901	0.909	0.938	0.834
	PU2	0.906				
	PU3	0.922				
TS	TS1	0.904	0.891	0.894	0.932	0.820
	TS2	0.915				
	TS3	0.899				

TABLE 3. Fornell-Larcker Criterion

	CLE	FE	LS	PCC	PEOU	PU	TS
CLE	0.911						
FE	0.485	0.915					
LS	0.551	0.459	0.906				
PCC	0.439	0.481	0.472	0.924			
PEOU	0.354	0.448	0.442	0.388	0.914		
PU	0.458	0.436	0.504	0.468	0.468	0.913	
TS	0.453	0.439	0.476	0.445	0.423	0.413	0.906

TABLE 4. HTMT Values

	CLE	FE	LS	PCC	PEOU	PU	TS
CLE							
FE	0.527						
LS	0.601	0.508					
PCC	0.474	0.530	0.520				
PEOU	0.384	0.496	0.490	0.427			
PU	0.499	0.478	0.561	0.514	0.516		
TS	0.496	0.490	0.531	0.492	0.471	0.458	

students' perceptions about tools become more engaged creatively.

A. TECHNOLOGY PERCEPTIONS AND LEARNING EXPERIENCE

The results revealed that perceived usefulness and perceived ease of use could help students have a flow experience and learning satisfaction. It means that students are likely to create positive learning experiences when they perceive AI painting tools as something that may enhance creative efficiency, assist in the formation of visual ideas, and aid in completing academic tasks or designs. Consequently, the implementation of AI painting tools in education must not solely be based on the novelty of technology but must also depend on how well it can be integrated with students learning activities and creative results. The ease of use is also significant in terms of AI-based creative learning. The students have to compose prompts and alter parameters, compare produced images and incorporate them within their work. In case the tool is challenging to use, or the generation process is complicated to comprehend, the student may be frustrated instead of being immersed. Nevertheless, it is possible that ease of use may act mainly as a condition, whereas perceived usefulness may be more effective in determining the overall level of students' satisfaction. This implies that the educational uses of AI painting tools should both be operationally simple and clearly valuable to learn.

B. PERCEIVED CREATIVE CONTROL AND STUDENT AGENCY

Perceived creative control is considered among the most significant factors in the present research. The fact that its impact on flow experience is so significant suggests that students are very much engaged in AI-enabled creation based on whether or not they perceive themselves capable of directing and overseeing the creative process. Although AI painting software may automatically produce pictures, students do not receive them passively. They continue to take part in creation by designing prompts and choosing styles, adjusting parameters, filtering images, and continuing to modify them. This result is a reminder of the importance of student agency in AI-assisted creative education. Students are more likely to concentrate, be interested and immersed when they believe that they are able to control the creative direction and get the generated outputs nearer to their own thoughts. Thus, AI painting tools must be regarded as supplementary creative means instead of a replacement of student creativity. When it comes to teaching practice, it is essential to focus on the final output images but also on the way students are making creative choices, assessing other possible outputs, and converting the content produced by AI into something that has personal value.

C. TEACHER SUPPORT AND LEARNING SATISFACTION

The support of teachers has made a significant contribution to the satisfaction of learning, indicating that teachers remain very important in the teaching process of AI painting tools. Even though students have the ability to independently utilize AI tools to produce images, they require direction

in regards to how to comprehend what each tool does, assess visual quality, enhance prompts, alter outputs and even deal with originality, copyright and ethical concerns. Inadequate support in turn can lead to the misuse of AI tools by students or cause them to become overly dependent on results produced by AI tools. This result indicates that AI painting tools do not diminish the position of teachers, but rather introduce new demands on instructive support. Teachers must assist students to realize that AI painting tools are not substitutes of creative work, but useful tools to aid in ideation, experimentation, and visual development. By using task design, case studies, classroom discussions, and work criticism, teachers could steer students to be more careful and responsible in using AI tools so as to increase the level of satisfaction associated with AI-supported creative learning.

D. FROM LEARNING EXPERIENCE TO CREATIVE LEARNING ENGAGEMENT

Creativity in learning engagement was supported by both flow experience and learning satisfaction, although learning satisfaction was seen to have a stronger direct impact. This indicates that the long-term involvement of the students is based not only on the interest or immersion at any given point in time, but also on their perception of the whole learning process, its results and value to them. If students think that AI painting tools are useful to them, help with their coursework, and can help them create something meaningful, then they will stay very engaged. Flow experience is still relevant since it motivates students to be focused and open to exploring other creative opportunities. The immediate feedback offered by AI painting tools enables students to compare visual options and make multiple changes, which can enhance their desire to optimize prompts and come up with creative solutions. Simultaneously, learning satisfaction can also be enhanced through flow experience. On the whole, creative learning engagement of students is observed when they view AI painting tools as useful and controllable, exercise control during the process of creativity, get a proper teacher assistance, and acquire positive experiences of learning.

V. CONTRIBUTIONS AND CONCLUSION

A. THEORETICAL CONTRIBUTIONS

To begin with, it changes the direction of AI painting tools research regarding the general technology use intention to students creative learning involvement. In doing so, this paper offers a more education-focused way of conceptualizing the role of AI painting tools in art and design learning. Secondly, this paper builds upon the Technology Acceptance Model to include perceived creative control and teacher support. Although perceived usefulness and perceived ease of use can account for the fundamental assessments of students towards AI painting tools, perceived creative control considers the unique aspect of AI-driven creation, and teacher support represents the didactic attributes of educational

settings. The model explains why students engage not just technologically, but in a creative and pedagogical manner too. Thirdly, this paper has determined flow experience and learning satisfaction as influential psychological routes that link students' views on AI painting tools and creative learning engagement. It is found that student engagement is not only influenced by tool functionality but also by immersive learning experiences and the pleasure of AI-based creative learning.

B. PRACTICAL IMPLICATIONS

To begin with, teachers must explain the educational purpose of AI painting tools. The tools are not meant to be used merely to generate images automatically, but they should be incorporated in course activities as learning devices that encourage creative ideation, visual exploration, and development of designs. Secondly, teaching needs to focus on creative control by students. Students must be motivated to direct, assess, adjust and reform AI-produced products by optimization of prompts, altering parameters, choosing images and revising them after generation. This may assist the students in retaining creative agency instead of being passive consumers of AI outputs. Thirdly, teachers need to give process-based advice on the use of tools, visual assessment, originality, copyright, and ethics. By designing tasks, discussing cases, discussing them in the classroom, and critiquing works, teachers can direct students to interact with AI painting tools more critically and responsibly. Meanwhile, designers of courses and AI painting services are required to optimize their operations, make them stable and flexible in order to improve the students' flow experience and learning satisfaction.

C. CONCLUSION

The paper explored the determinants of students' creative learning involvement with AI painting tools. The structural equation model was developed and tested on the basis of the perspective of technology acceptance and learning experiences of 382 university students who have used AI painting tools. The findings indicate that perceived usefulness, perceived ease of use, and perceived creative control are significant predictors of flow experience, whereas perceived usefulness, perceived ease of use, perceived creative control, teacher support, and flow experience are significant predictors of learning satisfaction. Conversely, both flow experience and learning satisfaction are strong predictors of creative learning engagement among students, and learning satisfaction has the strongest direct effect. To sum up, it can be concluded that the combination of technology perceptions, creative control, teacher support, and learning experience determines the level of students' engagement in AI-assisted creative learning. AI painting tools may be used to support art and design education in more than just enhancing the rate of image generation; they can increase the level of student creativity, learning satisfaction and long-term involvement. It should then be noted that the

educational use of AI painting tools needs to go beyond its technical operation and image output and focus more on student activities in controlling, interpreting and developing AI-generated material in meaningful learning settings.

AUTHOR CONTRIBUTIONS

QH: Writing—original draft, Formal analysis, Writing—review & editing, Methodology, Data curation, Conceptualization. WH: Conceptualization, Writing—original draft, Resources. PX: Project administration, Software, Methodology. GS: Writing—review & editing, Funding acquisition, Supervision. RZ: Writing—original draft, Conceptualization, Validation.

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