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Procreate's influence on student creative self-belief: A quantitative analysis of motivational and expectational pathways in visual communication education

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ABSTRACT

This study investigates how Procreate influences the creative capacities of students in visual communication programs through three related mechanisms: cognitive engagement, motivation, and achievement expectations. Using a quantitative cross-sectional survey design, data were collected from 374 students and analyzed using partial least squares structural equation modelling (PLS-SEM). The results supported all proposed hypotheses and showed that Procreate use is associated with higher levels of perceived creative self-efficacy rather than objective creative ability. Perceived creativity was directly related to cognitive engagement (β = 0.268) and indirectly influenced through increased motivation (β = 0.548), which subsequently affected creative ability (β = 0.262), as well as through strengthened expectations of creative success (β = 0.552), which in turn influenced creative ability (β = 0.340). Together, these factors explained 54.8% of the variance in creative abilities, with expectations demonstrating a stronger mediating effect than motivation. The findings extend previous research by clarifying the psychological processes through which digital tools shape creative expression. From an instructional design perspective, the results suggest that curricula should move beyond teaching technical software skills and instead focus on fostering motivation and positive expectations for creative achievement when integrating Procreate. Overall, the study highlights the complex relationship between digital tools and creativity in visual communication education and provides empirical guidance for using technology to support sustained creative development.

1. Introduction

The proliferation of collaborative digital creation tools has markedly transformed visual communication pedagogy by altering established workflows and expanding the expressive range routinely accessible to learners. Stoyanova and Antova (2020) observed that today's digital drawing platforms have displaced analogue methods, enabling designers to produce decorative-abstract compositions that previously required excessive manual toil or remained beyond their technical reach. Such a shift does more than replace tools; Zheng (2023) argued that emergent workflows have become integrated into visual communication programs, driving the formulation of interdisciplinary curricula that preempt the requirements of a progressively automated creative economy. Within this generative setting, the iPad application Procreate has emerged as an especially generative pedagogical field. Stambekova et al. (2024) revealed that Procreate fosters digital fluency and stimulates inventive problem-finding across studio modules, whereas Li (2024) linked ongoing, reflective engagement with the environment to heightened learner self-efficacy and intrinsic motivation, suggesting that the application's enduring influence extends far beyond initial instructional moments.

The integration of applications such as Procreate into visual communication programs signals a

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significant pedagogical transformation that transcends mere aesthetic enhancement or technical literacy. Qiu (2024) demonstrated that several Chinese universities are reconfiguring graphic-design syllabi around a unified digital framework, and the resulting quantitative indicators show marked improvements in the volume of original creative outputs as well as in prolonged student involvement in the discipline.

Although analogue media remain integral to the acquisition of core craftsmanship, the same curricular redesigns show that digital environments furnish distinctive affordances, which Stoyanova and Antova (2020) defined as introducing novel creative genres rather than reproducing analogue workflows in electronic form. Cloud-based asset libraries, limitless undo histories, and streamlined prototyping processes curtail material waste, afford nonlinear experimentation, and, as Zheng (2023) argued, more faithfully simulate the operational context that graduates will meet in professional settings.

Nonetheless, even as adoption rates rise, Li (2024) cautioned that little empirical evidence traces the cognitive and emotional processes by which platforms such as Procreate translate daily practice into sustained creative growth, especially the correlation between habitual tool engagement and final output quality. Similarly, Stambekova et al. (2024) reported that Procreate evidently stimulates originality among prospective art educators, yet the exact mechanisms by which digital literacy matures into elevated creative thinking remain under-researched. These articulated lacunae in the literature both motivate and guide the trajectory of the present investigation.

This investigation explores the distinct impacts of various factors on students' creative abilities within visual communication curricula by tracing several interwoven pathways. Initially, we analyze the program's effect on student motivation, scrutinizing how heightened motivation subsequently results in enriched creative output and progressive skill development. Next, we consider how preexisting student expectations regarding Procreate's affordances contour their creative workflows and outcomes. Finally, we measure the explicit correlation between Procreate engagement and the quantifiable dimensions of creative ability.

Through a quantitative interrogation of motivational pathways and expectation frameworks, the study presented here furnishes empirical data designed to guide educators in the judicious incorporation of digital tools within visual arts instruction. A systematic mapping of these dynamic interdependencies clarifies the contours of pedagogical practice, the architecture of curricula, and the rigor of assessment within technology-mediated educational contexts. Furthermore, the research endeavors to harmonize extant theoretical constructs of creative cognition with their enacted counterparts in contemporary visual communication pedagogy.

The results advance the debate surrounding the integration of mediated technologies in arts curricula, providing actionable recommendations for educators who wish to implement Procreate and analogous platforms in ways that nurture genuine creative progression rather than merely replicating established manual processes. As digital creation environments continue their rapid evolution and increasing penetration of academic spaces, investigations of this caliber become imperative, endowing educators with a principled foundation for decision-making within visual communication programs.

2. Literature review

2.1. Digital tools in visual communication education

Digital environments permit the nonlinear modification of visual elements, empowering learners to recompose images, textures, and shapes with fluidity that conventional media often restrict. Stoyanova and Antova (2020) reported that, through vector and raster applications, students can now realize complex decorative-abstract forms that paint, ink, or collage would have rendered laborious or impossible. This newfound elasticity invites an iterative type of making that Sundar (2024) identified as congruent with emergent, data-saturated aesthetics. In support of these qualitative observations, Xie (2024) reported a statistically significant gain in drawing proficiency among secondary students in Zhengzhou, China, attributing the improvement to strategically timed digital tool interventions during the formative stages of composition.

Contemporary digital resources within visual arts education have been deliberately designed to reflect the workflows and competencies demanded by creative industries. Asare et al. (2023) surveyed both the technical and conceptual dimensions of practice, demonstrating that digital methods now track the evolving requirements of employers. Conversely, van Langeveld and Kessler (2010) traced the contribution of digital visualization to the articulation of sophisticated developmental tasks, including the internal anatomy of 3D characters. Klima and Kárpáti (2021) asserted that the mastery of these platforms has reached the status of a nonnegotiable prerequisite in disciplines such as animation, interactive game authorship, and digital illustration, thus situating their systematic adoption within teaching programs as a matter of professional currency.

Simultaneously, the integration of these tools has reshaped the pedagogy of the discipline, generating interactive, distributed, and collaboratively oriented learning constellations. Kolyvas (2020) documented the surgical refinement of curriculum design that modern educational software permits, whereas Korepanova et al. (2024) clarified how cloud-based, cross-institutional platforms construct communities

of practice among instructors. The convergence of these strands reinforces the competencies that Hatzigianni and Kalamatianou (2018) identified as essential for academic and professional settings: analytical discernment, collaborative problem solving, and adaptive role negotiation.

2.2. Procreate: Features and educational applications

In a three-year longitudinal investigation of visual-art undergraduates in Chongqing, Li (2024) integrated qualitative and quantitative data from surveys, graded studio work, and reflective digital notebooks, revealing three interlinked motivations for continued Procreate deployment: Evident alignment with intended learning outcomes, intrinsic enjoyment of procedural creation, and consolidated self-conception as competent visual producers. Li (2024) conceptualized this interplay as a "virtuous cycle" where positive debut experiences with the platform spur extended interaction and increasingly ambitious design briefs. Regression analyses indicate that Procreate's streamlined command architecture significantly attenuates the cognitive load typically faced by novice artists, thus reallocating mental capacity towards the elaboration of conceptual and compositional subtleties.

In addition to promoting active student participation, proficiency with the digital painting application Procreate has become an essential component of contemporary teacher training curricula. Stambekova et al. (2024) demonstrated that the regular pedagogical use of a program cultivates digital literacy alongside anticipatory curriculum design practices among aspiring fine arts instructors. Its intuitive controls, combined with capabilities that professional artists expect, empower teacher candidates to produce refined lesson sequences and finish visual work with remarkable speed and polish. The authors therefore affirm that the platform "contributes to the formation of future fine arts teachers' creative and innovative thinking," thereby preparing program graduates with the adaptable skills necessary for success within an ever-evolving, increasingly digital classroom landscape.

When purposefully embedded in aligned curricula, Procreate markedly elevates the caliber of instructional resources. Azis et al. (2023) investigated materials produced with software in cultural arts education, focusing on the ornamental patterns of the Toba Batak. Their research revealed that the resulting digital portfolios, e-books, interactive units, and virtual visualizations consistently advanced a wide range of teaching functions. Both cross-sectional and longitudinal data suggest that Procreate merged cultural and artistic knowledge with unusual transparency. The authors therefore concluded that curricula enriched by the application produce greater student learning gains than conventional methods do.

2.3. Creative abilities: Definition and measurement

Technical proficiency serves as the latent support from which persuasive visual communication steadily emerges. It comprises the mastery of media, instruments, and procedures, empowering the artist to translate abstract insight into tangible imagery. Bratslavsky et al. (2019) demonstrated that students who confront progressively organized instructional tasks maintain a sustained, self-analytical discourse concerning material and procedure selection, thereby indicating that deliberate practice broadens the intellectual freedom to devise works that are both precisely articulated and conceptually audacious. Hence, mastery of primary techniques cannot be relegated to a mere preparatory moment or static endpoint; it exerts a generative influence, orienting the intricacy and the evolving trajectory of the final artistic realization.

Originality, characterized by the ability to generate visual forms that are both unprecedented and acutely attuned to their milieu, remains the defining mark of the creative enterprise. Kozhevnikov et al.'s (2013) investigation disclosed a strong linkage between adeptness in picturing three-dimensional objects and the ascent of artistic works in peer-mediated assessments of innovativeness. Building on this theoretical framework, Jankowska and Karwowski (2015) rendered originality operational through the Test of Creative Imagery Abilities (TCIA), a diagnostic instrument that gauges the preliminary generative phase of creative endeavor, thereby attesting to originality as a construct that is both domain-bound and quantifiably amenable to empirical scrutiny.

Flexibility in creative visual thought stems from the capacity to reconceptualize visual problems from multiple, shifting perspectives and to react constructively to unexpected stimuli. Bratslavsky et al. (2019) demonstrated that instructional activities purposefully constructed to retain ambiguity prompt wider ranges of response options and less predictable investigative trajectories. Their research suggests that academic environments that combine fixed, intractable constraints with overlapping, explorative inquiry lanes foster a sharper breed of adaptive flexibility, thereby preparing learners to address complex visual communication dilemmas with enhanced tactical assurance.

In tandem with adaptive capacity, a refined aesthetic judgement constitutes a foundational, nonnegotiable element of creative mastery. Jankowska and Karwowski (2015) identified aesthetic appraisal as a distinct yet integral strand within a broader framework of visual competence. Similarly, Palmiero et al. (2015) illustrated how aesthetic perception, while originating as a distinct cognitive faculty, exerts an interdependent influence on overall creative achievement. This evaluative capacity enables visual communicators to critique, refine, and iteratively evolve their work according to

benchmarks that heighten rhetorical effectiveness and communicative precision.

Empirical investigations consistently affirm that creativity embodies a multidimensional construct, wherein discrete components engage particular domains while remaining dynamically interlinked. Palmiero et al. (2010) demonstrated that visual creativity advances according to an additive calculus, in which originality, technical control, generative flexibility, and evaluative acumen yield independently quantifiable contributions that merge at convergent moments contingent upon task demands. Building upon this cumulative model, Wang and Wang (2018) articulated a curricular configuration that mandates the concurrent enhancement of each component, arguing that the systematic diagnosis and cultivation of competencies in visual communication achieve durable efficacy only when each faculty member is regarded as iteratively reinforcing rather than as an independently additive element. The converging evidence presented here advocates the adoption of a multidimensional framework to integrate descriptive inquiry and evaluative practice within visual communication pedagogy. This organizational scaffold guides the design of systematic investigations while simultaneously inviting scrutiny of how emerging digital contexts, particularly those created in particular, may generate context-specific effects on the constituent dimensions. Targeted studies of these differential influences would clarify the developmental interactions among the dimensions, enriching the knowledge of how discrete yet interdependent variables jointly shape trajectories of creative maturation.

2.4. Dual-pathway model: Motivation and expectations

Empirical investigations have identified two interlocking dynamics through which digital instruments reshape creative output: They amplify motivational impetus, and they recalibrate evaluative thresholds (Cai et al., 2020). Together, these dynamics yield a cohesive explanatory apparatus essential for a rigorous assessment of Procreate's influence on visual communication students' creative capacities. Digital production contexts consistently magnify students' intrinsic readiness to initiate and sustain creative tasks. Tang et al. (2022) reported that virtual environments primarily increase creative deliverables through the stimulation of motivational predispositions, the acceleration of task-specific rehearsal, and the refinement of evaluative dialogue. Instantaneous feedback streams and visually engaging interfaces disaggregate formerly opaque creative pathways into microsegments of gratification, sustaining both commitment and resolute iteration. Pikhart et al. (2024) extended this analysis by showing that game-like affordances, adaptive microworlds, and distributed digital collectives amplify both affective delight and motivational perseverance throughout the process. Thus, the augmented motivational supply emerges as the dominant vector through which Procreate and similar platforms enhance the qualitative standard of creative production.

Digital technologies redefine users' expectations of their creative potential, which in turn modifies the quality of creative work produced. Enhanced methods for visualization, rapid prototyping, and iterative iteration empower learners to believe in their growing competencies, thus increasing the self-imposed standards they apply to completed projects. Tang et al. (2022) reported that course-integrated analytic tools and real-time evaluative feedback systemically alter learners' creative benchmarks, compelling them to pursue solutions that are both riskier and qualitatively novel. In STEM and design programs, Wang and Li (2024) reported that digitally mediated contexts explicitly cultivate dimensions of creative cognition, particularly fluency, flexibility, and originality, by mapping learners' creative trajectories against the observable constraints and expectations endemic to such environments. Samper-Márquez and Oropesa-Ruiz (2025) reinforced this finding, contending that digital architectures shift the evaluative lens through which students measure success in contemporary visual disciplines.

Motivational amplification and incremental expectation recalibration jointly operate within digitally mediated authoring contexts to expand the creative frontiers of students. Heightened motivation invigorates attention, extends time-on-task, and cultivates a disposition to engage with iterative uncertainty. Concurrently, expectation recalibration modifies self-efficacy assumptions and redefines the perceived normative landscape of the interconnected sociotechnical network. When these processes are considered in tandem, tools such as Procreate, in a nonlinear and frequently opaque manner, evidently recalibrate the creative competencies of learners in visual communication degree pathways. The analytical lens differentiates overt, artifactual consequences from those that operate at the level of beliefs and dispositions.

The intersection of motivation and expectation contributes to a refined articulation of mediated learning by arguing that Procreate simultaneously prolongs investment and recontextualizes self-image within shifting sociocultural benchmarks. This formulation specifies the mechanisms at play and advances a heuristic design for empirical scrutiny of Procreate's contribution to formal curricula. Investigators employing this lens should systematically isolate the motivational and expectational components, quantify their reciprocal interdependence, and thereby deepen scholarly comprehension of how digital artefacts shape creative ability in domain-specific pedagogy.

2.5. Research gap and hypotheses

Despite the expanding presence of Procreate within visual communication programs, empirical

examinations that quantify its impact on creative skills are minimal. The prevailing literature articulates significant theoretical paradigms but highlights noteworthy lacunae. First, Li (2024) identified the factors that sustain Procreate use among undergraduate fine arts majors, yet the study did not translate usage metrics into quantifiable changes in creative output. Second, Stambekova et al. (2024) delineated how Procreate enhances digital literacy among preservice art educators, but the intermediary cognitive and affective processes that translate digital competency into creative innovation are left unassessed. Third, Goulet-Pelletier et al. (2023) correlated motivational states with creative performance across various fields, yet the role of application-based tools, including Procreate, remains disregarded within the framework. Concurrent analyses by Hu and Li (2025) mapped the alignment of learner expectations with outcomes across digital drawing platforms, but the focal software, Procreate, is pointedly absent.

The present inquiry remedies these shortcomings by articulating and empirically validating a model that interrogates Procreate's influence on creative capacities via three proposed mediating routes: (1) a motivational route, (2) an expectation-sensitive route, and (3) a putatively direct axis of influence.

Research underscores that digital platforms designed with intuitive interfaces can increase learners' intrinsic drive to pursue creative activities (Goulet-Pelletier et al., 2023). In a longitudinal analysis, Li (2024) demonstrated that Procreate elicits pronounced levels of hedonic motivation and subjective fulfilment among students in fine arts, whereas Tang et al. (2022) reported that such technologies elevate creative output chiefly by increasing motivation. Since intrinsic motivation correlates positively with students' self-appraisal of their creativity across academic domains (Goulet-Pelletier et al., 2023), a theoretical motivational trajectory linking creative engagement and creative skill development appears warranted. In light of this, we propose the following hypothesis:

H1: Procreate usage positively influences students' motivation in visual communication education.
H2: Student motivation mediates the relationship between creative usage and creative ability in visual communication education.

Digital environments recalibrate users' anticipations about their creative output through enhanced means of visualization, experimentation, and iteration (Tang et al., 2022). Li (2024) reported that self-efficacy and perceived usefulness serve as significant predictors of sustained Procreate engagement among fine arts undergraduates, indicating that the software itself shapes users' expectations of their artistic potential. Hu and Li (2025) then revealed that self-efficacy and user attitude, framed as intrinsic determinants, jointly forecast both the intention to adopt digital drawing platforms and measurable subsequent advancements in creative performance. Collectively, these studies articulate an expectational mechanism linking Procreate engagement to creative competence, thereby guiding the formulation of the following hypotheses:

H3: Procreate usage positively influences students' expectations regarding their creative performance in visual communication education.
H4: Students' expectations mediate the relationship between creative usage and creative ability in visual communication education.

Several studies suggest that digital creation tools directly enhance creative abilities. Stambekova et al. (2024) reported how Procreate specifically helps develop innovative thinking among future art educators. These findings suggest that Procreate may directly influence creative abilities, independent of motivational or expectational pathways. Thus, we propose the following:

H5: Procreate usage directly enhances students' creative abilities in visual communication education.

3. Methodology

3.1. Research design

This research adopts a quantitative cross-sectional survey design to investigate the interplay among Procreate engagement, student motivation, performance expectations, and creative competencies within visual communication pedagogy. Employing a quantitative orientation enables the empirical examination of the postulated associations among these constructs, facilitating rigorous statistical scrutiny of both direct effects and the identified mediating processes by which Procreate might enhance creative prowess.

The cross-sectional strategy permits the capture of the relevant constructs at a singular temporal juncture, thereby streamlining the collection of data from a comparatively large cohort of visual communication learners. Although the design is inherently limited to correlational interpretations and does not permit the observation of developmental trajectories over time, it is appropriately aligned for elucidating the specified correlational frameworks and for evaluating the mediation hypotheses delineated from H1 to H5.

The selection of survey instrumentation is motivated by its suitability for the systematic quantification of self-reported Procreate engagement, motivational drivers, and salient performance expectations, which are constructs that are not readily accessible via observational methods alone. Complementing these measures, the survey incorporates a creative aptitude assessment, thus facilitating a multidimensional evaluation of the theorized model while ensuring pragmatic applicability within the educational context.

The research framework employs well-validated scales and instruments reconfigured to align with the particular setting of the Procreate and visual communication pedagogy. This choice guarantees that the findings are both theoretically grounded and psychometrically sound. The resulting methodology reconciles the imperatives of empirical precision with the pragmatic requirements of conducting inquiry within instructional contexts.

3.2. Participants and sampling

The study's participant group consists of undergraduate and graduate students enrolled in visual communication programs who exhibit proficient operational command of Procreate. Participants are recruited from a spectrum of institutions that deliver curricula in visual communication, graphic design, digital art, and adjacent fields, thus furnishing a stratified and representative accumulation of the pertinent academic subdomains.

Data acquisition is guaranteed through purposeful sampling, specifically targeting respondents whose immersion in Procreate is sufficiently protracted to produce nuanced qualitative data. Three interlocking eligibility criteria are rigorously applied: (1) the respondent must be actively registered within a recognized visual communication or closely cognate curriculum, (2) the respondent must present incontrovertible documentation of uninterrupted Procreate use persisting for a minimum of three calendar months, and (3) the respondent must have completed at least one quantitatively rigorous assignment—typically a graded design project requiring structured concept development, digital sketch iterations, and evaluative criteria such as originality, technical execution, and visual coherence—executed fully within the Procreate application. This tripartite sifting of subjects safeguards the attainment of a participant pool that possesses the requisite depth of exposure necessary for a critical analysis of the software's influence upon motivational orientations, performance expectations, and the expanding repertoire of creative executables.

The sample population proposed for this investigation has been amended according to established recommendations for SEM, thereby permitting scrutiny of the postulated linkages embedded within the theoretical matrix. Consistent with the guidance of Henseler et al. (2014), the protocol mandates the recruitment of no fewer than 200 respondents to furnish the analyses with the requisite statistical potency. This benchmark accommodates a configuration embracing four latent constructs, each supplemented by a suite of observed indicators and a projected, yet tolerable, incidence of missing item responses. The formulation enables the detection of medium effect magnitudes (0.3) while adhering to a 5% alpha risk threshold and an 80% statistical power threshold. The recruitment strategy is organized by departmental chairs and individual instructors, who distribute an electronic survey invitation to students who satisfy predefined eligibility criteria. To minimize selection bias, participation remains entirely voluntary and is not tied to any form of curricular credit. Demographic information—namely, age, gender, academic standing, program type, and previous experience with digital art tools—is collected to enable a precise characterization of the sample and to facilitate the subsequent examination of any moderating variables.

3.3. Instruments and measures

The present investigation utilizes rigorously tested measurement instruments, modified in accordance with relevant scholarship, to capture the four central variables in the theoretical model. Each indicator is recorded on a uniform 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) to ensure comparability across dimensions. The use gauges the intensity and regularity with which students engage in the Procreate application, which was operationalized through three items originally formulated by Li (2024) and subsequently corroborated by Hu and Li (2025) in studies targeting usage patterns among art students. Student motivation gauges both intrinsic and extrinsic incentives that propel students' immersion in Procreate-based creative assignments, with items adapted from the Motivated Strategies for Learning Questionnaire (Pintrich, 1991) and the Academic Motivation Scale (Vallerand et al., 1992), both of which enjoy broad empirical support in educational research. Student expectations capture students' anticipations and beliefs concerning the quality of creative outcomes they envisage when using Procreate, drawing on items from Sander et al. (2000) and the expectancy dimensions of the Motivated Strategies for Learning Questionnaire (Pintrich, 1991), which survey beliefs about learning results and self-efficacy. Finally, creative abilities yield students' self-assessed competencies and perceived outcomes in visual communication tasks, further contributing to the overall model.

The items utilized in this study derive from the Creativity Self-Report Scale (Kaufman and Baer, 2004) and the Kaufman Domains of Creativity Scale (Kaufman, 2012), with particular emphasis placed on the visual and artistic domains of creative functioning.

The measurement constructs and their corresponding items are delineated in Table 1, which also lists the original sources of each item.

3.4. Data collection procedures

Data collection occurs via an online survey platform purposely chosen for its broad accessibility and its capacity to engage student populations across multiple institutions. Instrumentation has been forwarded to both undergraduate and graduate students enrolled in visual communication and

cognate degree programs at five institutions distributed throughout the Asia–Pacific region. Department chairs and program coordinators act as principal liaisons; they disseminate the survey link through sanctioned course-management systems and through established departmental communication conduits. The survey opening section outlines the study's objectives, delineates safeguards for confidentiality, reiterates the voluntary character of participation, and is followed by demographic queries and measurement items pertinent to each designated construct. To attenuate possible order bias, the arrangement of items within each construct is randomized for each individual respondent. Completion of the survey is paced at an anticipated duration of fifteen to twenty minutes, and respondents are afforded the option of saving incomplete responses and resuming at a later time if necessary. Informed consent was obtained from all the respondents before the survey was initiated, and they were notified of their right to withdraw at any point without incurring any penalty.

Table 1: Measurement items for research constructs

Construct	Code	Item	Source
Procreate usage (PR)	PR1	I intend to continue using Procreate in the future.	Li (2024)
	PR2	Using Procreate has become a habit for me.	Li (2024)
	PR3	When I start a digital artwork, I normally choose Procreate.	Hu and Li (2025)
Student motivation (MO)	MO1	I experience pleasure and satisfaction while learning new techniques in Procreate.	Vallerand et al. (1992)
	MO2	I prefer course activities in Procreate that truly challenge me so I can learn new things.	Pintrich (1991)
	MO3	Using Procreate makes me more motivated to engage with creative tasks.	Pintrich (1991)
Student expectations (EX)	EX1	I believe I will create high-quality work using Procreate.	Pintrich (1991)
	EX2	I expect that using Procreate will improve my creative outcomes.	Sander et al. (2000)
	EX3	I am confident I can master complex techniques in Procreate.	Pintrich (1991)
Creative abilities (CA)	CA1	I can easily come up with original ideas when using Procreate.	Kaufman and Baer (2004)
	CA2	I am able to express myself creatively through Procreate.	Kaufman (2012)
	CA3	I often think of unusual ways to approach visual tasks in Procreate.	Kaufman and Baer (2004)

Data collection is scheduled for the mid-semester point to allow sufficient exposure to Procreate within the curriculum. The survey is accessible for a four-week interval, with a reminder email distributed at the halfway point to optimize the response rate. To mitigate potential self-selection bias, faculty members are invited to dedicate a brief segment of class time for survey completion should students elect to participate. All collected data are archived on password-secured servers, and any personally identifiable information is expunged prior to analysis to ensure the confidentiality of the participants.

3.5. Data analysis plan

Data analysis was performed via SmartPLS 4.0 to carry out partial least squares structural equation modelling (PLS-SEM), a technique well suited for the examination of complex path diagrams that incorporate mediating variables. The analysis will be performed in two principal phases. The initial phase focuses on the measurement model, examining individual indicator reliability (factor loadings exceeding 0.70), internal consistency (Cronbach's alpha and composite reliability each greater than 0.70), convergent validity (average variance extracted above 0.50), and discriminant validity as affirmed by the Fornell–Larcker criterion and Heterotrait–Monotrait (HTMT) rate-making (<0.90). Following the measurement evaluation, the second phase will interrogate the structural model by scrutinizing path coefficients and their statistical significance by bootstrapping (5,000 resamples), alongside the coefficients of determination (R^2). The mediating influences outlined in hypotheses H2 and H4 are tested through the examination of specific indirect effects.

4. Results

Table 2 presents the reliability and validity results for all the constructs in the research model. All the constructs demonstrate excellent reliability, with Cronbach's alpha values ranging from 0.820 to 0.867, which are well above the recommended threshold of 0.70. The composite reliability values assessed via both rho_a (0.878-0.917) and rho_c (0.893-0.918) further confirmed the internal consistency of the measurement scales. Convergent validity is established through average variance extracted (AVE) values, which range from 0.737 to 0.789, exceeding the minimum threshold of 0.50. This finding indicates that each construct explains more than 73% of the variance in its respective indicators. The strong psychometric properties of the measurement model provide a solid foundation for assessing the structural relationships between constructs. Creative ability has the highest composite reliability (0.918), whereas student motivation has the lowest, yet still very satisfactory Cronbach's alpha (0.828). These results indicate that the adapted self-report scales were reliable and valid for capturing students' perceived creative confidence and related constructs.

As shown in Table 3, all diagonal values (ranging from 0.859--0.889) exceed the corresponding off-diagonal correlation values in their respective rows and columns. This confirms that each construct is empirically distinct and captures phenomena not represented by other constructs in the model. The strongest correlation is observed between Student Expectations and Creative Abilities (0.656), indicating a substantial relationship between these constructs while maintaining discriminant validity. The correlations between Procreate Usage and Student Expectations (0.552) and between Procreate

Usage and Student Motivation (0.548) are similar in magnitude, suggesting comparable relationships between these constructs.

As shown in Table 4, all HTMT values range from 0.619 to 0.738, which is well below the conservative threshold of 0.85 recommended by some scholars and considerably below the general threshold of 0.90. The highest HTMT value (0.738) is observed between student motivation and student expectations, indicating that these constructs, while related, remain empirically distinct. The lowest HTMT ratio (0.619) is between Student Expectations and Procreate Usage. These results provide additional confirmation of discriminant validity beyond the Fornell–Larcker criterion, further validating the measurement model.

Table 2: Construct reliability and validity

Construct	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
Creative abilities	0.866	0.911	0.918	0.789
Procreate usage	0.820	0.878	0.893	0.737
Student Expectations	0.867	0.917	0.918	0.789
Student motivation	0.828	0.886	0.897	0.744

Table 3: Fornell–Larcker criterion

Construct	Creative abilities	Procreate usage	Student expectations	Student motivation
Creative abilities	0.888			
Procreate usage	0.599	0.859		
Student expectations	0.656	0.552	0.889	
Student motivation	0.627	0.548	0.640	0.862

Table 4: Heterotrait–Monotrait (HTMT) ratios

Construct pairs	HTMT
Procreate usage <-> creative abilities	0.681
Student expectations <-> creative abilities	0.725
Student expectations <-> Procreate usage	0.619
Student motivation <-> creative abilities	0.709
Student motivation <-> Procreate usage	0.629
Student motivation <-> student expectations	0.738

Table 5 presents the path coefficients and their statistical significance in the structural model. All the hypothesized relationships show statistically significant positive effects ($p < 0.001$). Procreate Usage has a direct positive effect on Creative Abilities ($\beta = 0.268$, $t = 4.607$), supporting Hypothesis H5. The relationship between Procreate Usage and the two mediating variables is particularly strong, with similar magnitudes for Student Expectations ($\beta = 0.552$, $t = 9.337$) and Student Motivation ($\beta = 0.548$, $t = 9.389$), supporting hypotheses H1 and H3. Both mediating variables also have significant positive effects on creative ability, with student expectations having a somewhat stronger effect ($\beta = 0.340$, $t = 5.122$) than does student motivation ($\beta = 0.262$, $t = 4.102$). These results support hypotheses H2 and H4, confirming the mediating roles of motivation and expectations in the relationship between creative usage and creative ability. The consistent significance of all path coefficients indicates robust support for the theoretical framework underlying the research model. The strongest relationships are observed between Procreate Usage and the two mediating variables, suggesting that Procreate has a substantial influence on both student motivation and expectations in visual communication education contexts.

Table 5: Mean, STDEV, and T values and p-values

Path	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T-statistics (|O/STDEV|)	P-values
Procreate usage -> creative abilities	0.268	0.270	0.058	4.607	0.000
Procreate usage -> student expectations	0.552	0.553	0.059	9.337	0.000
Procreate usage -> student motivation	0.548	0.551	0.058	9.389	0.000
Student expectations -> creative abilities	0.340	0.335	0.066	5.122	0.000
Student motivation -> creative abilities	0.262	0.262	0.064	4.102	0.000

Table 6 presents the coefficient of determination (R-squared) values for the endogenous constructs in the research model. The model explains 54.8% of the variance in creative ability ($R^2 = 0.548$, $R^2adj = 0.545$), indicating substantial explanatory power for the primary outcome variable. This suggests that the combination of direct effects from Procreate Usage and indirect effects through Student Motivation and Student Expectations accounts for more than half of the variation in students' creative abilities. The model explains approximately 30% of the variance in both mediating variables—Student Expectations ($R^2 = 0.304$, $R^2adj = 0.302$) and Student Motivation ($R^2 = 0.301$, $R^2adj = 0.299$). These moderate R-squared values indicate that while Procreate Usage is a significant predictor of both motivation and expectations, other factors not included in the current model likely contribute to these constructs as well. The similar R-squared values for both mediating variables align with the comparable path coefficients from Procreate Usage to these constructs.

Table 6: R-squared values

Construct	R^2	R^2adj
Creative abilities	0.548	0.545
Student expectations	0.304	0.302
Student motivation	0.301	0.299

Table 7 presents the F-squared (f^2) values, which assess the effect size of the predictor variables on their respective endogenous constructs. According to Cohen's (1988) guidelines, f^2 values of 0.02, 0.15, and 0.35 represent small, medium, and large effect sizes, respectively. Procreate Usage has large effect sizes on both Student Expectations (f^2 = 0.438) and Student Motivation (f^2 = 0.430), indicating substantial practical significance in these relationships. This suggests that Procreate Usage strongly influences both mediating variables with nearly equal magnitude. The direct effect of Procreate Usage on Creative Abilities shows a small to medium effect size (f^2 = 0.100), indicating a meaningful direct contribution beyond the indirect pathways. Among the mediating variables, Student Expectations has a medium effect size on Creative Abilities (f^2 = 0.137), whereas Student Motivation has a small effect size (f^2 = 0.082).

Table 7: F-squared values

Path	F-squared
Procreate usage -> creative abilities	0.100
Procreate usage -> student expectations	0.438
Procreate usage -> student motivation	0.430
Student expectations -> creative abilities	0.137
Student motivation -> creative abilities	0.082

5. Discussion

This study explored how Procreate affects students' creative capacities within visual communication curricula by analyzing a direct mechanism, a motivational trajectory, and an expectational trajectory. The results corroborate each proposed link with empirical evidence, thereby yielding theoretical insights and practical recommendations.

The results indicate that creative usage is positively related to students' perceived creative self-beliefs (H5), a conclusion that is consistent with earlier findings by Stambekova et al. (2024), who asserted that digital art platforms enhance creative and problem-solving skill sets. The estimated relationship (β = 0.268) suggests that the platform's interactive features may correspond with stronger creative self-confidence rather than verifiable creative performance.

Our results underscore the critical contribution of psychological mechanisms in accounting for the effects of Procreate on creative capacities. Procreate exposure strongly affects both student motivation (β = 0.548) and performance expectations (β = 0.552), with the corresponding effect sizes classified as large (f^2 = 0.430 and f^2 = 0.438). These data corroborate the argument of Tang et al. (2022) that digital environments stimulate creativity mainly by increasing motivation and resonate with Hu and Li's (2025) demonstration of how digital drawing approaches recalibrate performance expectations. Furthermore, motivation acts as a significant mediator in the relationship between Procreate and creative outcomes (H2), which is consistent with the work of Goulet-Pelletier et al. (2023), who identified intrinsic motivation as a driver of elevated self-assessed creativity. The reliability coefficient linking motivation to creative performance (β = 0.262) indicates that Procreate fosters creative expression by rendering tasks more engaging and rewarding, thereby encouraging exploration and sustained effort. This finding aligns with that of Pikhart et al. (2024), who reported that interactive technologies tend to enhance the motivational appeal of creative endeavors.

Student expectations functioned as a marginally more potent mediator (β = 0.340, f^2 = 0.137) than motivation did (β = 0.262, f^2 = 0.082), indicating that beliefs about forthcoming performance with Procreate exercise a greater shaping force on eventual creative achievements than do motivational states. This finding corroborates Li's (2024) assertion that self-efficacy and perceived utility forecast sustained Procreate engagement and further generalizes that correlation to the domain of creative capacity. The elevated role of expectations implies that a producer's conditioning of creativity transpires mainly through the cognitive processes of self-efficacy appraisal and anticipatory outcome judgement.

Taken together, the three pathways account for 54.8% of the variance in creative capability, attesting to their cumulative explanatory strength. The closely matching coefficients for Procreate's effects on motivation and expectation (β = 0.548 and β = 0.552) reveal that the software engages these psychological processes with nearly equal intensity, whereas their joint indirect contribution to creative capability surpasses the software's direct contribution. This observation reaffirms the dual pathway model articulated by Tang et al. (2022) and provides specific empirical corroboration of that model in the context of Procreate within visual communication pedagogy.

These insights are highly relevant for pedagogical practice. The implications should be interpreted with caution. The correlational nature of the findings suggests that while Procreate usage is associated with greater motivation and creative self-belief, educators should view these results as indicative rather than prescriptive. Integrating Procreate may support, but does not guarantee, enhanced creative outcomes. Designing learning contexts that nurture intrinsic motivation and reinforce learners' self-efficacy in employing Procreate may promote deeper creative advancement than an isolated technical pedagogy.

The model's robust explanatory power (R^2 = 0.548) confirms that interaction with Procreate constitutes a key ingredient in students' creative maturation, warranting its integration into visual communication programs. Nevertheless, the intermediate R-squared values for motivation (R^2 =

0.301) and expectations (R^2 = 0.304) reveal that additional, nonsoftware factors also modulate these psychological pathways. Instructors ought to reflect on how the overarching learning milieu, instructional strategies, and student dispositions can amplify the favorable effects of Procreate on motivation and expectations.

The marginally more pronounced mediating role of expectations relative to motivation implies that strategies reinforcing self-efficacy and optimistic future-oriented beliefs about procreation are likely to yield heightened effectiveness. Such strategies may include presenting exemplary student portfolios produced in Procreate, articulating clear criteria for attainable results, and sequencing tasks in ways that secure early, observable successes to fortify learners' confidence.

Several limitations must be acknowledged when these findings are interpreted. First, the study relied exclusively on self-reported measures of creativity, which reflect students' perceived creative self-efficacy rather than objectively assessing creative performance. This reliance raises the possibility of common method bias due to the use of a single data source and similar item formats. Second, the cross-sectional design precludes any inference of causality. Although significant relationships were observed, the temporal direction of influence cannot be determined, and reciprocal or confounding effects may exist. Third, the sample was drawn primarily from visual communication programs in the Asia–Pacific region. As such, the findings may not be generalizable to other cultural or institutional contexts where creative pedagogy and technology integration differ.

Future studies should incorporate longitudinal or mixed-methods designs and objective measures of creative products to strengthen causal interpretation and cross-cultural validity.

6. Conclusion

This study examined the role of the Procreate platform as a digital illustration platform in shaping students' perceived creative self-efficacy within visual communication programs, addressing both its direct effects and its indirect mediation through motivation and performance anticipation. Path-analytical modelling indicated that Procreate explains 54.8% of the variance in creative achievement through interleaved pathways. While the application's advanced technical affordances generate immediate affordances, psychological variables, most notably the anticipation of performance standards, intensify the gains in creative preparedness. These findings advance the literature by articulating the sequential and reciprocal processes through which Procreate translates affordances into creative expression, thereby corroborating the simultaneous contributions of cognitive appraisal and affective valuation. Curriculum stakeholders are urged to revise instructional blueprints by integrating, alongside technical pedagogy, a deliberate cultivation of motivational climates and the reinforcement of performance beliefs, particularly the self-efficacy necessary to master Procreate's affordances. Subsequent research should deploy longitudinal trajectories and objective assessments of creative products to elucidate the temporal and functional interdependencies that the current analyses suggest.

List of abbreviations

AVE	Average variance extracted
β	Standardised path coefficient
CA	Creative abilities
EX	Student expectations
f^2	Effect size
HTMT	Heterotrait–monotrait ratio
MO	Student motivation
O	Original sample
p	Probability value
PLS-SEM	Partial least squares structural equation modelling
PR	Procreate usage
R^2	Coefficient of determination
R^2adj	Adjusted coefficient of determination
rho_a	Dijkstra–Henseler's rho
rho_c	Composite reliability
SEM	Structural equation modelling
STDEV	Standard deviation
t	T-statistic
TCIA	Test of creative imagery abilities

Compliance with ethical standards

Ethical considerations

Participation was entirely voluntary, and informed consent was obtained from all respondents prior to data collection. Anonymity and confidentiality were assured, and no identifying personal information was collected.

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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