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WIP - Exploring Creativity in Engineering Identity: The Role of Arts Experience

Cinthia Viviana Rojas Palacio, Arizona State University

Cinthia Rojas Palacio is a doctoral student and graduate research assistant at Arizona State University - Polytechnic Campus, pursuing a PhD in Engineering Education Systems and Design. She is a Control Engineer and MSc. in Engineering–Industrial Automation from Universidad Nacional de Colombia. Her main fields of research are engineering education, pedagogical innovation, creativity in engineering and dynamic control systems.

Dr. Nadia N. Kellam, Arizona State University

Nadia Kellam (she/they) is Professor of Engineering, Engineering Program Chair, and the Associate Director for Strategic Initiatives within The Polytechnic School of the Ira A. Fulton Schools of Engineering at Arizona State University. She is a faculty in the Engineering Education Systems and Design PhD program. Dr. Kellam is an engineering education researcher and a mechanical engineer. She was recently deputy editor of the Journal of Engineering Education and is currently co-chair of ASEE's Committee on Scholarly Publications. Her research employs narrative inquiry, arts-based methods, and futures thinking to explore the culture of engineering education—especially the experiences of marginalized undergraduate students and faculty.

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Introduction

Creativity not only helps engineers develop problem-solving skills but also enables them to better understand problems [1], [2], [3]. It helps engineers see connections between seemingly unrelated pieces of information by reframing the problem and questioning boundaries, assumptions, and definitions [2], [3], [4], [5]. According to the World Economic Forum, these competencies are becoming essential for engineers and other professionals in addressing current global problems, which are becoming more wicked due to social, economic, and environmental issues [6].

Recent research suggests that creativity plays an important role in students' engineering identity [7]. Creativity reinforces students' perceptions of themselves as capable and effective engineers by strengthening their problem-solving skills [2], [4], [7], [8], and engineering students often associate creativity with engineering [7]. Therefore, fostering students' creativity seems important for strengthening their engineering identity.

One way to foster students' creativity is through artistic practices, given the inherent connection between creativity and the arts [3], [5], [9], [10], [11], [12]. Art fosters students' imagination by providing a space for reflection during the creative process, activating deep memory to uncover unusual connections between seemingly unrelated ideas [9], [10]. This means it allows students to search for similarities between a current problem they are facing and their previous experiences or knowledge to generate a novel and unique idea (imagination). Also, visual artistic practices, such drawing or sketching, help students to view problems from different angles (cognitive flexibility) by fostering their observation skills [9], [11], [12]; This observation process forces students to look for all possible causes that could contribute to the problem they try to address, the interactions among those causes, and the consequences of those causes [9], [12]. This is essential in engineering, as students need to understand the problem well before generating possible solutions [3], [4], [5], [8]. So, if an artistic background supports creativity, students with such backgrounds may be more likely to integrate creativity into their engineering identity, but this relationship remains unclear.

Recent literature reviews in engineering explore how engineering education researchers use artistic practices to foster creativity among engineering students, yet this remains underrepresented in engineering education [4], [13], [14]. Higuera et al. [4], mentioned 14 studies that use artistic practices or other disciplines like cooking or industrial design to foster creativity in engineering students' during the years 2010 to 2020; Teken-Araci [13], highlights 4 studies that implement artistic practices in engineering schools during 1995 and 2019, and, Aguilera and Ortiz-Revilla [14], highlight 2 studies that use art to foster students creativity in higher education from 2010 to 2020.

However, researchers have focused on measuring undergraduate students' attitudes toward creativity to understand how students perceive creativity and its relationship with sociocultural factors such as gender, age, language, race, and academic level [15], [16], [17]. However, these studies rarely consider factors such as prior artistic background despite evidence that artistic experiences can support creative thinking [3], [5], [9], [10], [11], [12]; Only Bolhari et al. [16] start to explore students' artistic identity and its possible connection with their engineering identity.

Bolhari focused on whether first-year students had artistic identities and analyzed them by gender. However, the same authors mention that *"The question of artistic identity was administered at the end of the semester and students self-reported, suggesting that the responses not be necessarily a transferable or comparable attribute outside of this learning environment"* [16]. We believe interest in how artistic backgrounds shape engineering identity is growing in the field. Our WIP addresses this gap by quantitatively examining the relationship between prior artistic experience and the development of engineering identity among undergraduate students.

Research Questions

This pilot study aims to answer the following three research questions:

1. How do attitudes toward creativity differ between students with and without prior arts experience?

2. How do students perceive creativity as being a part of their engineering identity?

3. Is there a difference in this perception of creativity as being a part of their engineering identity between students with and without prior arts experience?

Theoretical Framework

In this WIP study, we analyzed creativity using Rhodes' Four P Model of Creativity [18] and how this creativity is part of the engineering identity model [19]. Rhodes establishes that creativity is a product of the interaction among four dimensions: personal traits and prior knowledge (*Person*), the methods and/or strategies that an individual uses during creative work (*Process*), the outcome or objective of the creative process (*Product*), and the external factors that can influence the creativity of an individual (*Press*) [18].

Various studies in engineering used the Rhodes model as a baseline to define creativity [2], [4], [20], [21]. This framework allows engineering researchers to understand the who, what, when, and how of creativity and serves as a base for more complex models of creativity [2], [4], [20]. For example, Van Broekhoven et al. [21] use this framework to explore differences in creativity among the four micro-domains of engineering, particularly in terms of personality and self-efficacy (*Person*), divergent thinking (*Process*), and originality, feasibility, and effectiveness (*Product*) aspects of creativity. However, they did not investigate the *press* element because the study participants were drawn from many different institutions, and they mentioned incorporating that dimension into their future work.

This WIP study focuses on Rhodes' *person* and *press* elements. The *person* element represents students' artistic backgrounds, which form part of their knowledge and allow them to develop their creativity and self-perception regarding creativity [18]. In this case, students' artistic background influences their confidence in their ability to engage in creative work, aligning with the performance/competence dimension of Godwin's Engineering Identity framework [19]. Regarding the *press* element, in this study, we refer to how students interact with their environment and their exposure to creative activities. From a press perspective, students' academic environments are among the external factors that could influence students' creativity and identity [18], [19]. These academic environments are tied to social and cultural norms that determine whether creativity is recognized and validated within engineering, playing an important role in how an individual develops their engineering skills [7], [19], [22], aligning with Godwin's *recognition* dimension. So, we interpret these artistic experiences as part of the *person* and press elements, influencing the development of an individual's creativity and attitude towards it.

Using this framework, we treat creativity as a construct influenced by both individual characteristics and external factors. This allows us to explore how variables such as prior artistic background and academic environments are associated with engineering students' creative attitudes, and how creativity is part of the students' engineering identity.

Methods

This study explored whether engineering students' attitudes toward creativity and their engineering identity differ by prior arts experience. We conducted a quantitative study using a Likert-scale (1 - Strongly disagree to 5 - Strongly agree) survey with 35-item that considered prior arts experience as a factor influencing students' attitudes toward creativity. The survey was structured with 19 questions about the *person* construct such as *"I consider myself a creative person"* and "*I consider creativity an important skill for engineers*", and 16 questions about the sociocultural (*press*) construct such as *"My curriculum is flexible enough to allow creative exploration"* and *"The engineering culture at my institution values creative thinking"*.

Participants and Data Collection

Participants were asked to complete an online survey using the QuestionPro platform. No personally identifiable information, such as names or email addresses, was collected. A total of 79 participants completed the survey during the Spring 2025 semester. The First Author used convenience sampling through their professional network to recruit participants from three R1 universities: two in Colombia and one in the United States. Since the inclusion criterion was enrollment in an undergraduate engineering program, five participants who reported not being enrolled in such a program were excluded. As a result, 74 undergraduate engineering students were included in the final analysis.

In terms of demographics, 86% of participants were studying in Colombia and 13% in the United States. Regarding gender, 31% identified as women and 69% as men. Additionally, 57% of participants reported having taken an arts course at some point in their lives, while 43% had not. Participants from 11 different undergraduate programs responded. 74% of the participants identified as Hispanic/Latinx and 12% as White.

Data analysis

We conduct an Exploratory Data Analysis (EDA) to detect trends and anomalies in the data. This EDA includes descriptive statistics, data normality checks using the z-values of kurtosis and skewness, and outlier detection. We found that the data do not follow a normal distribution according to the z values criterion for skewness and kurtosis of ±3.29 for samples between 50 and 300 participants [23]. Also, outliers were identified in 23 questions based on a visual inspection of the boxplots in R. Since the data were not normally distributed, we decided to conduct a Wilcoxon Rank-Sum Test (WRST) in R software, since the artistic background factor only had two categories [24]. Furthermore, since participants' responses were obtained from two different countries, we decided to analyze this as well, as it is part of the sociocultural level of the *press* construct [18].

The reliability of the survey was evaluated using Cronbach's alpha to assess the internal consistency of the instrument [23]. The Cronbach's alpha for the full survey was 0.922, for the *person* construct it was 0.924, and for the *environment* construct it was 0.829. Considering the accepted threshold of $\alpha \geq 0.70$ [23], these values were deemed acceptable. While the instrument demonstrates internal reliability, it is recommended to review and adjust the instrument to ensure validity, as well as increase the number of participants.

Results & Discussion

The preliminary results in this section examine differences in students' perceptions of creativity and engineering identity based on artistic background. For the purposes of this WIP study, only survey items directly related to the connection between creativity and engineering identity were examined. Table 1 summarizes statistically significant items according to the WRST test. Also, we include analysis results of some non-significant items because of their conceptual relevance to understand creativity as part of engineering identity.

Table 1**.** Significant results of the Wilcoxon rank-sum test for the art classes factor.

Question	**Have you taken any formal art classes before?**		
	Yes	**No**	**Wilcoxon Rank-Sum Test**
Q1: I see creativity as part of my identity	M= 4.17, SD= 0.79	M=3.69, SD=0.82	W=872.5, p= 0.020
Q2: My past experiences in the arts spark my creativity	M=4.05. SD=0.99	M=3.50, SD=1.19	W=852, p= 0.041
Q15; Being creative is important to me	M = 4.43, SD = 0.77	M = 4.03, SD = 0.97	W =841.5, p=0.044

As shown in Table 1, items related to creativity as part of identity and the influence of artistic experiences consistently showed significantly higher agreement among students with artistic backgrounds than students without them. Even though both groups of students consider creativity important and part of their identity, students with artistic background might feel this way since they grew up in an environment where creativity is valued and encouraged, acting as a positive *press* which supports the *recognition* and *competence* of their creativity [18], [19].

According to Rhodes' framework [18], creativity is influenced by environmental conditions in which individuals think, learn, and create. From this perspective, prior engagement with artistic practices can function as a formative environment that supports creative expression by providing spaces where ideas can be explored without fear of failure and through multiple modes of expression [2], [25], which may contribute to the development of the *Person* aspect of creativity and students' awareness of creativity as part of their engineering identity. This pattern is also reflected in item Q14 (*"I consider myself a creative person"*). Although this difference was not statistically significant, the preliminary trend indicates that students with an artistic background reported higher agreement to see themselves as a creative person (M = 3.90, SD = 0.58) than students without an artistic background (M = 3.53, SD = 1.02). This suggests that artistic background may shape not whether creativity is valued, but how it is integrated into students' self-perceptions and their engineering identity.

We believe that these differences in the perception of creativity among both groups could be used as pedagogical tools within engineering courses. Knowing which types of artistic activities enhance the connection between creativity and engineering can help instructors design learning experiences that allow students to reflect on why they are being creative, rather than focusing on how to do so. An example of this is the use of observational drawing in engineering courses. In art education, drawing is not only about making something look good; it is a way to train careful observation. Students learn to slow down, pay attention to details, and notice relationships between parts. Engineering instructors could adapt this approach by asking students to sketch a mechanism, a circuit, or a user interacting with a product before beginning calculations or computer modeling, as in [12]. The goal would not be artistic quality, but deeper attention and understanding. Drawing can help students see patterns, assumptions, and structural relationships that they might otherwise overlook. By incorporating this kind of activity, engineering educators acknowledge the arts' expertise in developing observational skills and apply those strategies thoughtfully within engineering contexts.

Also, if instructors are aware of students' creative backgrounds, they can structure team-based activities to emulate interactions between engineering and artists, like those presented in [26], [27], for students with artistic backgrounds, such exercises may validate prior ways of knowing that are often marginalized in technically rigid curricula, and for students who do not have that artistic background fostering the value of other ways of thinking and that engineering does not prioritize one way of knowing.

Rather than replacing artistic formation within engineering programs, these approaches can be understood as explicitly recognizing the expertise that artistic disciplines have developed in cultivating creativity. Our findings suggest that students with artistic backgrounds bring valuable perspectives into engineering contexts, reinforcing the importance of sustaining and strengthening arts education within universities. In this sense, incorporating arts-informed pedagogical strategies does not seek to appropriate artistic knowledge but to encourage interdisciplinary dialogue and collaboration.

Also, we found an interesting trend regarding Q22 item. Although item Q22 ("*My curriculum is flexible enough to allow creative exploration*") did not show a significant difference with respect to the artistic background, this item was the one with the lowest mean score among the students with artistic background. Students with artistic backgrounds generally perceive that their curriculum does not allow them to express their creativity (M = 2.79, SD = 1.01), while students without an artistic background report uncertainty regarding whether their curriculum supports creative expression (M = 3.03, SD = 1.33). This result also followed the same trend as the items related to recognition by instructors. Although items related to recognition by instructors did not show statistically significant differences based on students' artistic background, their mean scores were also below 4 points. In this context, the academic environment of the students who participate in this study appears to function as a negative *Press* in which creativity cannot be freely expressed. As a result, the educational environment may be misaligned with students' personal attitude toward creativity, generating a conflict between the student's *Person* and *Press*. For students without a prior artistic background, this environment could limit their exposure to creative exploration during their training and may reduce their opportunities to develop their creativity. And for students with an artistic background, this environment could perpetuate the misconception that creativity is valued only in the arts, not in engineering [2].

Limitations & Future work

We noted some limitations during this WIP study. We recognize the need to explore further why students with an artistic background perceive their creativity as integral to their engineering identity. The quantitative approach of this WIP study did not allow us to know why that artistic background helps students to connect their creativity with their engineering identity. So, we consider doing a qualitative study in the future in order to explore more about it.

We treated artistic background as a broad category. Differences in the type, duration, or intensity of artistic engagement were not examined. So even though we can infer that artistic background, in general, may influence students' perception toward creativity, we cannot determine whether certain forms of artistic practice are more strongly associated with students' perceptions of creativity in engineering. Future research could examine these distinctions more closely in order to better understand how specific artistic backgrounds shape students' views of creativity and how those differences might inform pedagogical design in engineering education.

Additionally, this study employed convenience sampling, with 86% of the 79 participants recruited from Colombia and the remainder from the United States. This geographic concentration may limit the generalizability of findings to other cultural and educational contexts. Future research should include more geographically and culturally diverse samples to strengthen the broader applicability of these results.

Finally, as a work in progress study, data collection is still ongoing, and the findings reported here are based on the data available at the time of analysis. The results and trends shown in this paper may evolve or change as additional responses are collected and analyzed.

Conclusions

This WIP study examined the differences in engineering students' attitudes toward creativity and their engineering identity based on prior arts experience. Our preliminary results suggest that attitudes toward creativity differ by artistic background. Students who have taken art classes value creativity more as part of their engineering identity than those without artistic backgrounds. This suggests that arts training could serve as a positive *press,* shaping how creativity is perceived and experienced, allowing students to understand the connection between creativity and their engineering identity. As we mentioned in the result and discussion section, we, as faculty, could use this information to our advantage, selecting artistic practices that help students recognize creativity as a more holistic process in the engineering profession. However, this should not be seen as replacing artistic formation or trying to own it; instead, it recognizes the role of the arts in fostering creativity and encourages collaboration across disciplines.

Furthermore, our results highlight that regardless of whether students have an artistic background, both groups perceived their curriculum as not flexible enough to allow them to express their creativity. Although this result seems to contradict the findings regarding students' personal perceptions of creativity, we believe it could be one of the reasons why students without an artistic background do not consider themselves creative. This situation can lead to students' personal dilemmas about the value of creativity in engineering, limiting student exposure to creative exploration and reducing the opportunity for students without an artistic background to develop their creativity.

Together, our preliminary results could mean that cultivating creativity requires more than adding design challenges or artistic practice modules; it requires intentionally supporting students through positive recognition and validating multiple forms of creativity that help students to see themselves as creative engineers.

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