

The status of creativity among engineering graduates

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Empirical WIP: The status of creativity among engineering graduates

Introduction

STEM is the acronym for Science, Technology, Engineering, and Mathematics [1]. Although the acronym is widely used, some authors refer to each discipline independently, while others consider it a whole [2]. Since the disciplines are connected in real life [1], the integrated approach has been considered essential to address real-world problems [3]. Solving real-world problems is essential for STEM students. For example, engineers must identify problems, ideate, prototype, test, and implement the best solution [4].

Humans need to be creative to solve real-world problems [5]. Creativity has been investigated since 1930 [6], and even though it is still considered complex to define [7], the widely accepted definition states that creativity requires originality and effectiveness. For something to exist, it requires being valuable and appropriate in a specific context [6] and [8]. In 2007, the Americans for the Arts-National Policy Roundtable introduced STEAM, which integrates STEM with the arts to increase creativity and innovation, and other competencies in STEM students necessary for employability and economic growth [9].

Accreditation agencies consider creativity and innovation within their criteria [10] and [11].

Curricula that encourage creativity are needed to meet these requirements [12]. However, numerous studies emphasize that students and alumni of engineering schools perceive a deficiency in their creativity and problem-solving strategies [13] and [14]. Karimi and Piña [15] identified the ten skills most in demand by employers in the US for STEM jobs. Being creative appeared in fourth place, identified as necessary by 70% of employers. Nevertheless, creativity is the third skill, considering the gap between what students have and what employers request [16]. Moving from STEM to STEAM is relevant to generating technological innovation, as incorporating ARTS focuses on developing creativity [17], thus contributing to the country's development. Despite the difference in development within Latin American countries, even the most developed one is behind other countries. Economic growth, human progress, and, thus, the country's development are directly influenced by technological innovation [18]. Creativity in STEM has been studied in the US, but a gap exists in understanding how it is perceived in a Latin American country. Based on this, the research question emerges: How do employers and alumni perceive the level of creativity among recent engineering graduates in a Latin American country?

Methods

As this research is exploratory, qualitative data will be used. A qualitative study allows for understanding a context in multiple facets by exploring a specific phenomenon [19]. As a methodological framework, a grounded theory approach will be followed for data collection and analysis. A group of STEM career graduates and employers from three universities in a Latin American country are being interviewed since their perception is a good measure of an institution's quality and effectiveness [20]. Employers have not been interviewed for this WIP.

Study Participant and their recruitment

Seven graduates from three universities in a Latin American country were interviewed for this WIP. Table 1 presents the participants' data, including the type of University and their QS Rankings: Latin America & The Caribbean 2025 [21] (exact N° blind for review).

Table 1: Participant data

Nº	Gender	Engineer Degree	Graduation Year	Type of Industry	Type of University & QS Ranking
1	M	Mechanical Civil Engineer	2022	Private. Hydraulic-Sanitary	Traditional private University with presence in different regions. QS: 35 to 40
2	M	Mechanical Civil Engineer	2020	Private. Engineering consultancy.	Traditional private University with presence in different regions. QS: 35 to 40
3	M	Chemical Civil Engineer	2020	Private. Water treatments	Traditional private University with presence in different regions. QS: 35 to 40
4	F	Hydraulics Civil Engineer	2020	Private. Consulting Hydraulic Eng.	Traditional private University in the capital city. QS: 1 to 5.
5	M	Industrial Civil Engineer	2021	Private. Energy	Traditional private University in the capital city. QS: 1 to 5.
6	F	Civil Engineer	2022	Private. Training	Public University in the capital city. QS: 5 to 10.
7	M	Mechanical Civil Engineer	2019	Private. Engineering consultancy	Traditional private University with presence in different regions. QS: 35 to 40

Participants were chosen from three different universities, as this WIP is part of broader research aiming to respond to the research question from a broader perspective.

For recruitment, participants were contacted through *LinkedIn*, a work-related social platform. The University Ethics Committee approved this research, and all the participants signed a consent form. They were advised that their participation was voluntary and that they could leave at any time during the interview.

Data collection and analysis

A semi-structured interview was designed to ask participants about their perceptions of creativity and engineering. Participants were interviewed remotely for around 30 minutes, and their interviews were recorded. The questions that guided the interview are presented in Appendix A. As this WIP comes early in the research process, the grounded theory has not yet been fully applied. The analysis presented here carefully examines each participant's answer and highlights the main concepts being studied to understand the phenomenon based on qualitative data preliminarily.

Preliminary Results

Regarding the perception of skills that participants believe are relevant to their professional lives, one of them responded:

*"I think my case is a bit particular because my work is very technical compared to others I know. So, in my case, it would be the **technical**, and then comes **interpersonal relationships**. As I told you, I must **coordinate with people from other disciplines** at work. So, that part is still strong. Moreover, deep down, always be open to **feedback** because in the working dynamics, one can take things personally, and in truth, they are not. So one has to understand that, I think."* – P2

For this participant, technical skills are in the top ranking, coming to the professional skills afterward. Professional skills are more valuable to other participants. For example, Participant P1 responded:

*"I think the most important skills are **professional skills, such as relating to clients or others**. Alternatively, **to express** what you are designing so that another person understands what you are doing, **managing** your time, and the **technical** side as well. Having a good technical knowledge of what you are doing is important."* – P1

Another participant said:

*"**Leadership** of people, for me, is the top skill. If you do not know how to relate and understand that a person is complex, any project will fail in any type of work. Because the **technical part can be developed and trained**, **coordination** could come, and the technical skill of the programs used, such as SQL and Excel, are a basis. For me, the number one **emotional skills of people**, number two would be **management skills**, basic **technical skills**, and number four... **connecting with the business**."* – P6

Although several participants mentioned professional skills, none mentioned creativity. Because of this, they were asked to explain why it did not seem relevant to them.

One participant answered:

*"Because the truth is that **I have not applied creativity much at work**. When you face a new project, you usually take old projects and see how they were done. And then apply or adapt it to your project. It is like the classic thing they tell you: "Why will you invent the wheel if they already made it?" So there is not much creativity there. Well, I am not saying you can not be creative at work. However, in what I am in and what I have also seen from my colleagues or university classmates, yes, no one is very creative. **No one invents something from scratch** as everyone uses things that already exist or that they taught at the University as a foundation. It is all about "taking something as a starting point." - P1*

For example, this participant does not believe creativity exists when you create something based on other designs. For them, creativity can only be achieved when something is designed from scratch.

For this other participant, creativity needs to go hand-by-hand with being productive, as

*"Look, I initially did not think of creativity as an option, but it is important. Well, here in the middle of the process, how do you find a specific solution, which you have, I do not know, 1000 solutions? You have to find a way to reach the **optimal solution**. Moreover, **being creative does help you with that**. Obviously, it is backed up with everything I told you before. But, being creative on the spot does not help you either; that is, it already takes up much time, so **you have to do things that are creative but that are also productive**."* – P3

Some participants do not see creativity in traditional engineering. For example:

*"In reality, being a mining mechanic, you **cannot be very creative**. (laugh)! It is a traditional industry, and if something is not approved in the early stages, one cannot do it. ... Because clients do not want to change processes nor the way of doing things, because it means a lot of decision time, which can even mean stopping the mining activity, and that is money."* – P2

Another one said:

*"I have not had the chance (to be creative) for now because everything is quite normal; nothing then. **There is not much room to be creative there...**"* – P4

This participant mentioned:

*"One of the things that I admired about my boss at my previous company is that she was very creative... and I thought that I wish I would always have this ability, more innate than something that has to be practiced....My latest **work is very technical, and there is no room to be creative**; different from my previous company, where I was "people," and **I could be creative**; I had to be thinking how to surprise in this, how to do this better. But in something that is **more operational** and that is already done, it is super difficult to have creativity present because you have so many things to do that you just do it."* – P6

Discussion and Limitations

These preliminary findings show that Engineering alums perceive their work as not being creative, limiting creativity when something is new or a non-structured process. The lack of creative opportunities within their work may influence their not seeing creativity as essential for engineers. The perception of lacking creativity, thus a zero-level of creativity, challenges engineering education regarding how we define creativity and communicate its relevance when tackling an engineering project. As the participants do not see engineering as creative, it is also extremely important for engineering educators to encourage creativity in the curriculum explicitly.

Thinking of engineering as not being creative can limit innovation and entrepreneurship. Individuals who view them as creative are more likely to start entrepreneurship [22] and thus affect the country's development. The belief that science is not creative also affects mainly girls in not choosing STEM careers [23]. It is important to tackle this issue to attract a diverse student body.

This work in progress presents several limitations. The interviews from employers have not been analyzed, and their views are extremely relevant. Regarding the participants, only seven individuals were interviewed, and the researchers have not reached saturation, so more interviews must be conducted. A more in-depth Grounded Theory analysis is required. The research team is working on a codebook using open and focused coding [24] following an investigator triangulation process [25] for the ASEE conference. With these preliminary analyses and this number of interviews, it is impossible to understand if gender, the type of Engineering Degree, or the type of University are relevant to the topic. All the participants work in the private sector. As the interview process is ongoing, it is expected to have more participants and hopefully be able to respond to the research question at the ASEE conference.

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Appendix A. Questions that guided the interviews with Alumnas

The following questions were designed to guide the interviews with Alumnas:

Context: Understand the environment where the participant works, whether this environment is of a high technical level, and whether they must work solving open problems (wicked problems).

What has your work experience been like since you graduated? Understand the participant's professional career.

Are you currently working? Tell me about your current job. What do you do? With whom do you work? What do they do?

What do you think was useful or lacking in your university education as preparation for your professional life? Understand if it mentions transversal skills and, specifically, creativity. Ask them to rank the mentioned competencies considering their relevance in their professional life.

If they mention creativity, find out where the participant recognizes the development of these competencies (classes, homework, invisible curriculum, among others). Also, ask: Being creative seems relevant to you. Please tell me why you mentioned it and how it relates to your professional life.

If creativity is not mentioned, ask: I see that being creative does not seem relevant to you. Can you tell me why?