Examining the Need for an Integrated Framework: Exploring the Intersection of Technological Pedagogical Content Knowledge (TPACK) in Entrepreneurship Competency Development, STEAM Education, and Gamification

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Abstract- In the 21st century, individuals possessing multiple skill sets at the same time can excel in the job market. For that, a combination of different educational fields would make learners more dynamic who will then be in a position to act as a jack of all trades. Also, STEAM education has been proven to enhance students' competencies. The need is to make them sell their skills in the market. That can be best done through the integration of entrepreneurship education into STEAM education. This study used a survey design to get administer the opinion-based survey to a sample of 50 participants. Their opinions were collected to check what experts think about the integration. The collected data were analyzed through SPSS- Statistical Package for Social Sciences to make interpretations and draw conclusions. It was proven that most of the experts feel the need to have a framework that integrates entrepreneurship education with STEAM education through gamification to boost student learning and skills.

Keywords:

1. INTRODUCTION

In countries like Pakistan where the adoption of technology is not easy because of a lack of resources, training, and acceptance because people are habitual in using traditional methods, there is a need to conduct more researches that signify the use of technology. In the educational sector, the integration of multiple skill sets along with the integration of technology can do wonders for learners (Brooks, 2022). The need is to come up with a sound framework where different domains of education are combined through technological interventions under one umbrella (Belda-Medina, & Calvo-Ferrer, 2022).

STEAM education already fosters the development of multiple skill sets at a time but the problem arises when students enter their professional careers (Khushk et al., 2023). They are unable to sell their skills because they do not possess the entrepreneurial competencies to do so (López Serentill, Rodrigues-Silva, & Alsina, 2021). The reason behind this problem is that they have never been exposed to such scenarios that would have been beneficial for their professional career. That is why, the integration of entrepreneurship with STEAM education should be done through a teaching methodology that keeps the learners engaged (Gomez et al., 2022).

Gamification is an approach that keeps the learners motivated and engaged throughout the process of learning by adding game elements in their process of learning by giving challenges, rewards, and feedback (Boytchev, & Boytcheva, 2020). That is why, this research was conducted to check if the industry experts and teachers think that there is a need for a framework that combines entrepreneurship, STEAM, and gamification in one frame and analyzes through the lens of Technological Pedagogical Content Knowledge (TPACK). The following research questions were answered by the end of the research:

- Is there a need to integrate entrepreneurship competency development, STEAM education, and gamification in education?
- Can a framework that combines entrepreneurship, and STEAM education through gamification be beneficial in learning?

2. LITERATURE REVIEW

The literature review provides a description of the research already conducted in an effort to integrate entrepreneurship education, STEAM education, and gamification. The review also highlights the research in which these entities have been studied through the lens of the TPACK model. The research studied so far indicated that the key concepts under study have not been studied in combination and there thus a research gap to explore this area in-depth.

Entrepreneurship education aims to foster an entrepreneurial mindset, skills, and competencies among students who then feel more confident to enter the job market. Research has highlighted the value of integrating entrepreneurship education within various disciplines, including science, technology, engineering, arts, and mathematics (STEAM) through different technological platforms and surveys (Lampropoulos et al., 2022). By incorporating entrepreneurship principles, students are exposed to critical thinking, problem-solving, creativity, and innovation within their chosen fields which ultimately leads to multi-skill set development. Integrating entrepreneurship education in STEAM provides a holistic approach that prepares students for real-world challenges and equips them with essential skills for future careers (Piñero et al., 2022).

Gamification, the application of game elements and mechanics in non-game contexts, has gained traction as an effective pedagogical approach believed to have shown a magnanimous impact (Alfaro-Ponce, Patiño, & Sanabria-Z, 2023). Studies have shown that gamified learning environments enhance student engagement, motivation, and learning outcomes thus learning occurs at a faster pace (López, Rodrigues-Silva, & Alsina, 2021). Through the use of gamification elements such as challenges, rewards, leaderboards, and simulations, students actively participate in the learning process, collaborate with peers, and develop problem-solving skills willingly (James, 2022). Integrating gamification in entrepreneurship education within the STEAM disciplines offers a dynamic and immersive learning experience that promotes entrepreneurial thinking and the application of knowledge (Grivokostopoulou, Kovas, & Perikos, 2019).

The TPACK framework provides a conceptual lens to guide the integration of entrepreneurship education, STEAM, and gamification (Isabelle, 2020). TPACK emphasizes the importance of aligning technological tools, pedagogical strategies, and subject-specific content knowledge to create meaningful learning experiences leading to successful learning (Kummanee, Nilsook, & Wannapiroon, 2020). Studies have demonstrated the benefits of using TPACK-informed practices in integrating technology within educational contexts at a greater level (Kauppinen, &

Choudhary, 2021). By applying TPACK principles, educators can effectively design instruction that leverages technology tools, pedagogical approaches, and entrepreneurial content knowledge to promote engagement, critical thinking, and collaboration among students (Pondee et al., 2021).

This literature review demonstrated the theoretical foundations and empirical evidence supporting the integration of entrepreneurship education in STEAM through gamification using the TPACK framework in a systematic manner. The reviewed literature highlighted the potential benefits of this integrated approach, such as enhancing student engagement, developing entrepreneurial competencies, and fostering critical thinking skills and students to the higher echelons of learning. By leveraging TPACK-informed instructional practices, educators can effectively integrate technology, pedagogy, and content knowledge to create immersive learning experiences that prepare students for future challenges in entrepreneurial STEAM fields.

3. METHODOLOGY

The methodology used for this research was based on a survey administration. First, a detailed literature review was conducted to find the space for making a framework for the combination of STEAM, entrepreneurship competency development, and gamification. Having observed the lack of literature on the combination of the three key aspects under consideration, the researcher moved to the industry experts to seek their opinion in this context.

a. Sample

Teachers teaching STEAM at the tertiary level, and industry experts responsible for designing curriculum and planning activities were approached and their consent was sought to fill in the survey form administered through Google Forms. A total number of 50 participants responded to the questionnaire and the majority of them belonged to different technology organizations that aimed at raising the level of education by imparting technological activities and curricula in educational institutions. The forms remained open for two weeks. First, the purpose of the research was explained to the participants and then they were requested to fill in the forms.

It is to be mentioned that institutions were mainly filtered and approached based on their special areas of work. People with a STEAM education background or practicing it somehow at their workplaces were requested to express their opinions through this survey. It is evident from Table 1 that the majority of the participants belonged to Robotmea.Pvt.Ltd. (also figure 1) as the mode value is 1.

Table 1 Demographics

|		Institution	Experience	Designation
N	Valid	50	50	50
	Missing	0	0	0
Mean		3.0800	1.9800	2.8600
Median		3.0000	2.0000	2.0000
Mode		1.00	2.00	1.00
Minimum		1.00	1.00	1.00
Maximum		9.00	6.00	8.00
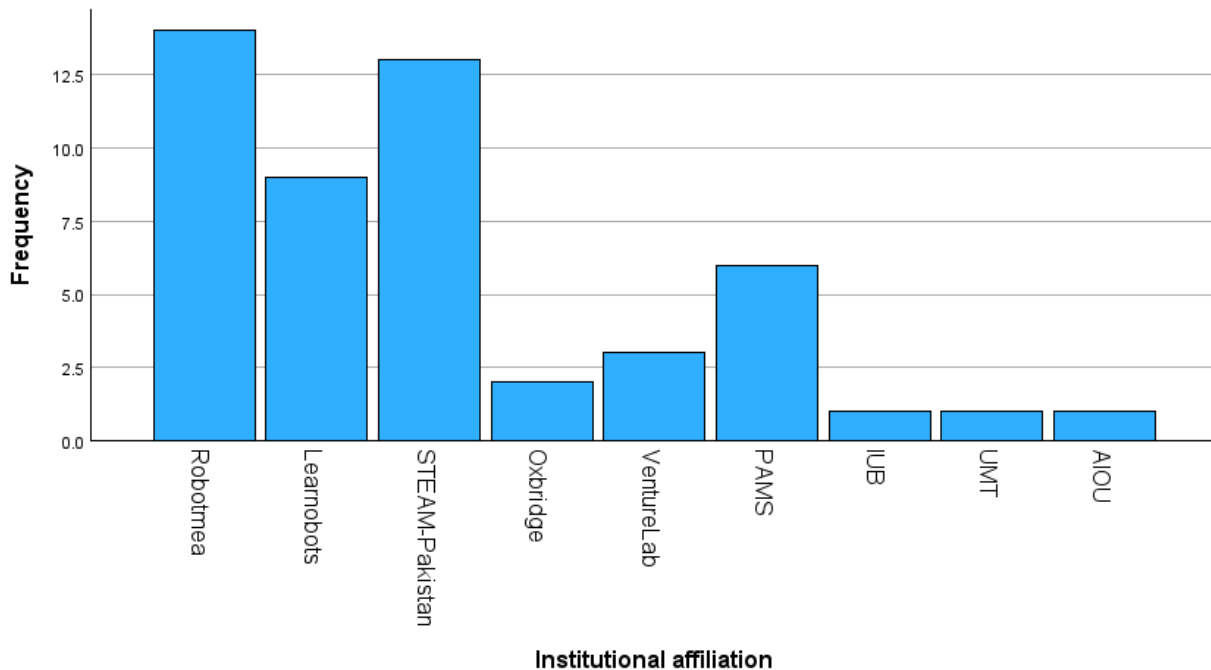
According to the shown table, it is also evident that the maximum number of people who responded to the survey were experienced for at least 4-6 years with the highest experienced participant having been exposed to STEAM education practice for 35 years as the maximum value in the table is 6 (also figure 2).
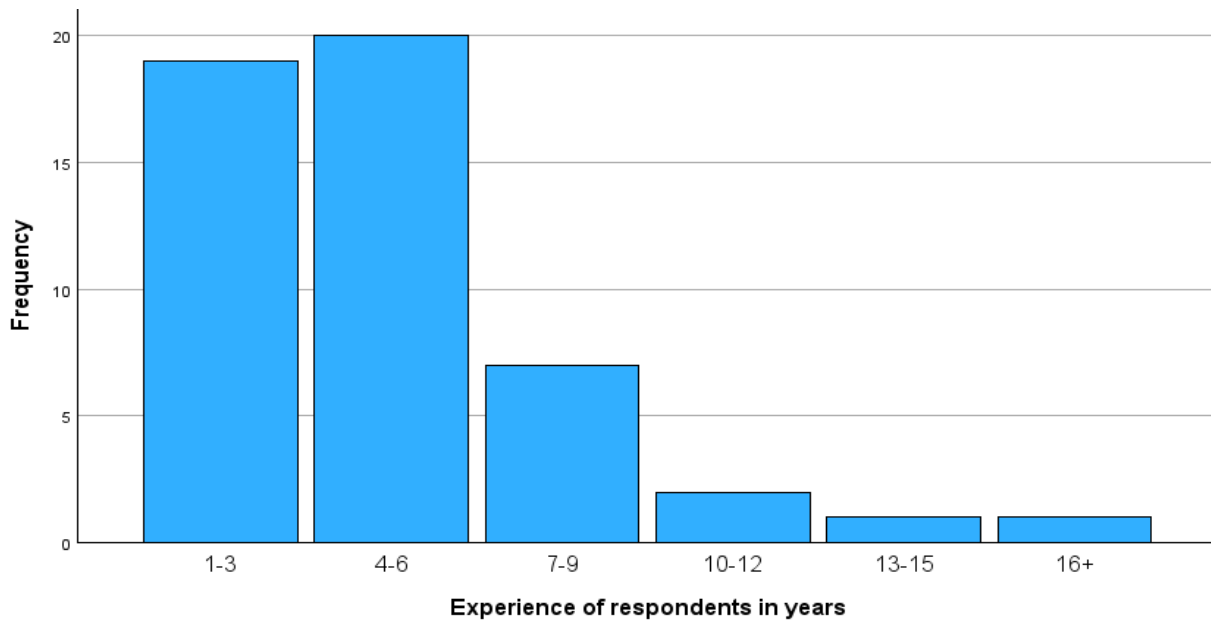
Most of the respondents were educators as the mode is 1 with some of them practicing in different organizations for developing content, organizing programs and activities related to STEAM and entrepreneurial education, and advocating STEAM education as EdTech experts and course designers. The demographic data shows that the majority of the people who responded to the survey were handpicked based on their institutional affiliation, experience, and designation to ensure the authenticity and reliability of data as it could have been questionable to obtain data from mere educators who did not have experience in practicing STEAM and entrepreneurial education.
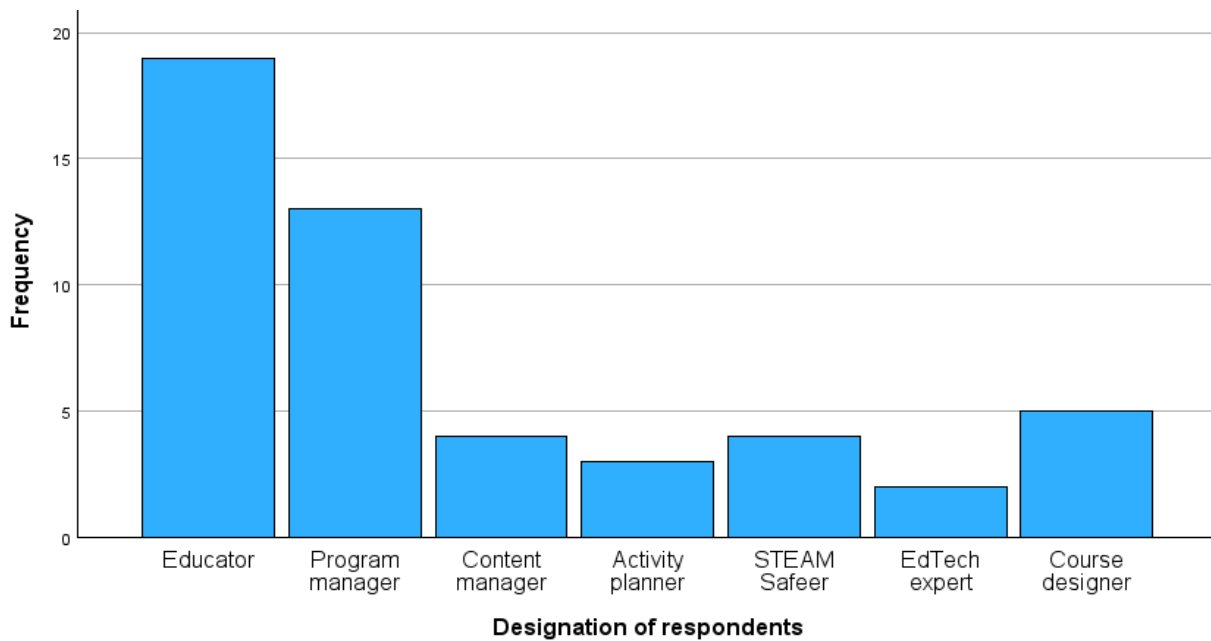
b. Instruments

The instrument used to collect data from the participants was an opinion-based questionnaire that contained 12 items and 4 sections. 10 out of 12 questions were close-ended, based on the Likert scale and the items were adapted from already existing questionnaires; Gamification of Learning Assessment Scale (GLAS), Gameful Experience Questionnaire

(GAMEFULQUEST), Gamification in the development of entrepreneurial intentions: a QCA Analysis, and Teachers' Survey on STEAM Education Practices. The rest of the two items were followed by multiple options and were made by combining multiple questions from the above-mentioned questionnaires.

4. ANALYSIS AND INTERPRETATIONS

Descriptive Analysis

Descriptive statistics of sections 1-4 have been shown in Table 2. The table illustrates that there were 4 sections of the questionnaire, and all 50 respondents responded to the given questions. The questionnaire was divided into 4 sections based on the research sub-areas questions were belonging to. In section one, the minimum value is 5, 1 each for a total of 5 questions. The maximum value is 12 based on the responses. Its mean is 7.74 while the standard deviation is 1.92. The minimum value in section 2 is 4, 1 each for a total of 4 questions. Maximum value is 11 based on the responses. Its mean is 6.58 while its standard deviation is 1.70. Section 3 has only 2 questions, so its minimum value is 2, while the maximum value based on responses is 5. Its mean is 2.74 and its standard deviation is 0.87. Section 4 has only one question, so its minimum value is 1, while the maximum value is 8. Its mean is 3.22 and the standard deviation is 1.85.

Table 2. Descriptive Statistics of Sections 1-3

	N	Minimum	Maximum	Mean	Std. Deviation
S1	50	5.00	12.00	7.7400	1.92524
S2	50	4.00	11.00	6.5800	1.70342
S3	50	2.00	5.00	2.7400	.87622
S4	50	1.00	8.00	3.2250	1.8527
Valid N (list-wise)	50				

Of all the questions asked in the survey, there are three questions from section 1 that need special consideration because they are directly relevant to considering the need for creating a novel framework. Table 3 demonstrates that 76 percent of the respondents strongly recommend integration of the STEAM education entrepreneurial education and gamification. The rest of the 22 percent agree with the idea of integration while 2 percent are neutral about this idea (also Figure 4). These statistics are evidence of the inclination of educators towards integration ultimately signifying the need to come up with a unified framework that amalgamates the three mentioned educational domains.

Table 3. Section 1.3. I recommend the integration of STEAM education, entrepreneurship education, and gamification to others in the education field.

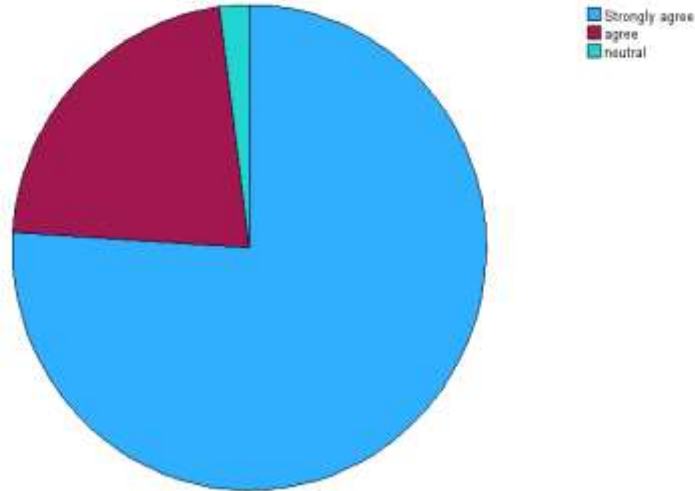|		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly agree	38	76.0	76.0	76.0
	agree	11	22.0	22.0	98.0
	neutral	1	2.0	2.0	100.0
	Total	50	100.0	100.0	

Table 4 indicates the current state of incorporation of entrepreneurial education in STEAM education. The figures show that 18 percent of the respondents agree their institutions consider integration all the time whereas 24 percent do it frequently, 48 percent of the respondents are neutral to the question and 10 percent say it is done sometimes (also figure 5). These responses again signify the need to come up with a unified framework to check in the future if the integration would be practically useful. As the organizations are not currently adding up the three educational domains all the time, the results cannot be measured. But once the integration is done, then the results can be measured to check the impact.

Table 4. To what extent entrepreneurship education is advocated by my organization while working on STEAM?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	all the time	9	18.0	18.0	18.0
	frequently	12	24.0	24.0	90.0
	neutral	24	48.0	48.0	66.0
	sometimes	5	10.0	10.0	100.0
	Total	50	100.0	100.0	

To what extent entrepreneurship education is advocated by my organization while working on STEAM?

Legend:
- all the time
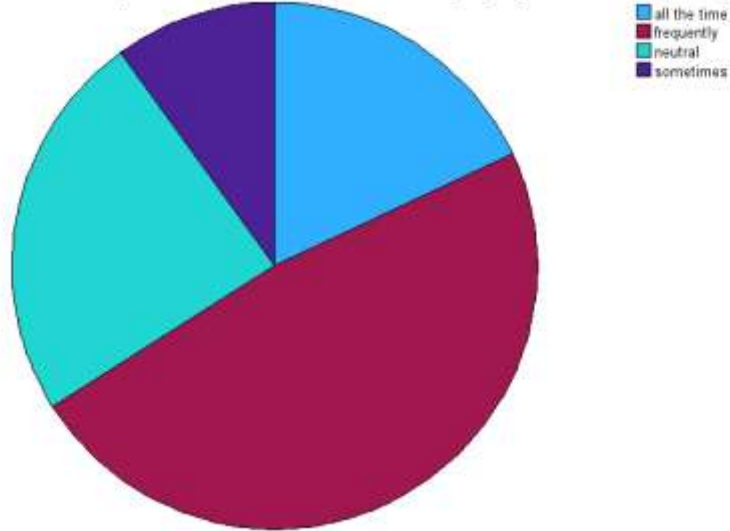- frequently
- neutral
- sometimes

Figure 5

Table 5 demonstrates the types of skills that can be taught to the learners if integration occurs, based on the participants' opinions. 52 percent of participants favored the inculcation of problem-solving and critical thinking skills through integration, 26 percent opinionated in favor of creativity and innovation, 6 percent endorsed teamwork and collaboration, 14 percent favored entrepreneurial mindset whereas 2 percent thought additional skills can also be imparted among learners through the integration of STEAM, entrepreneurship, and gamification.

Table 5. How can the integration of STEAM education, entrepreneurship competency development, and gamification benefit students in their professional careers?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	By enhancing their problem-solving and critical-thinking skills	26	52.0	52.0	52.0
	By promoting their creativity and innovation	13	26.0	26.0	78.0
	By improving their team-work and collaboration skills	3	6.0	6.0	84.0
	By fostering entrepreneurial mindset	7	14.0	14.0	98.0
	Other (please specify)	1	2.0	2.0	100.0
	Total	50	100.0	100.0	

How can the integration of STEAM education, entrepreneurship competency development, and gamification can benefit students in their professional careers?
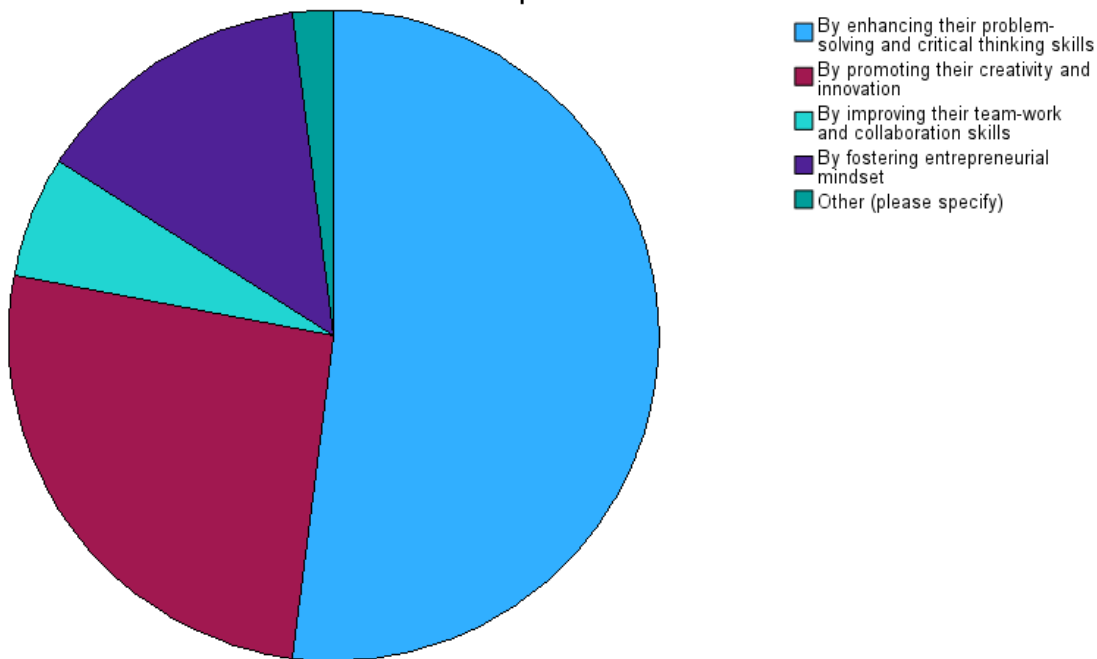
Legend:
- By enhancing their problem-solving and critical thinking skills
- By promoting their creativity and innovation
- By improving their team-work and collaboration skills
- By fostering entrepreneurial mindset
- Other (please specify)

Figure 6

Section 4 of the survey was based on a multiple-choice question in which participants could choose more than one option. The question inquired about the need for a framework that makes use of the tenets of STEAM and entrepreneurial education through gamification. The results were constructive and favored the making of a novel and integrated framework. 39 of 50 respondents favored the idea that integration can make learners feel better prepared to take on entrepreneurial challenges, 41 agreed on hands-on experience in learning, 40 voted for problem-solving skills inculcation, 39 shared their opinion in the favor of critical thinking skills whereas 38 went for the application of knowledge and skills in real-life scenarios. Such responses encouraged the making of the framework detailed in the upcoming chapter of this work.
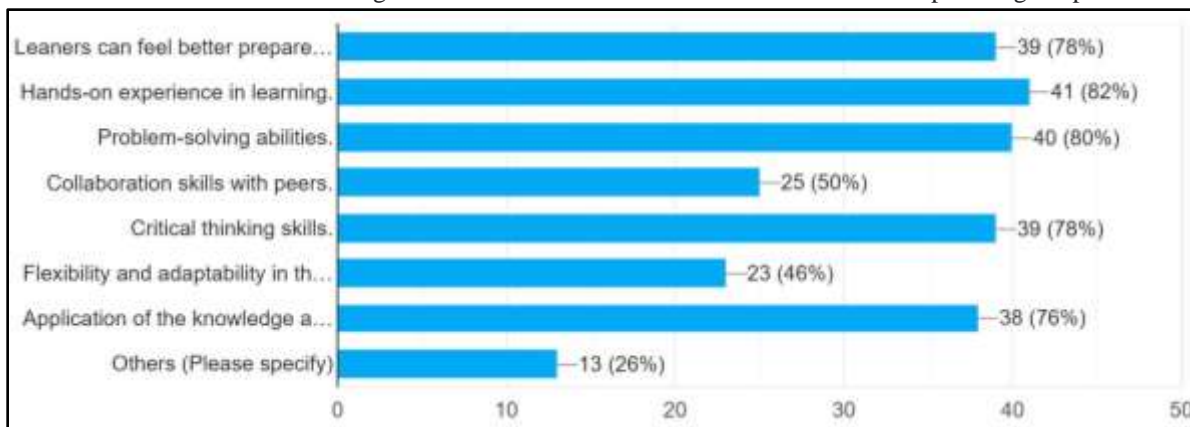

Figure 7. If a framework is developed for the integration of entrepreneurship competency development through gamified pedagogy at the tertiary level, which of the following skills of students will be improved?

Cross-tabulation

Figure 8 illustrates cross-tabulated data of institutional affiliation against section 1.3 of the questionnaire. It was imperative to consider members from which organizations endorse the integration of the three educational domains. According to the figure, almost all the organizations either strongly agree or agree with the idea that signifies the research aim of designing a model that could help educators in imparting the combined skills of STEAM, entrepreneurship, and motivation through gamification.

I recommend the integration of STEAM education, entrepreneurship education, and gamification to others in the education field. * Institutional affiliation Crosstabulation...
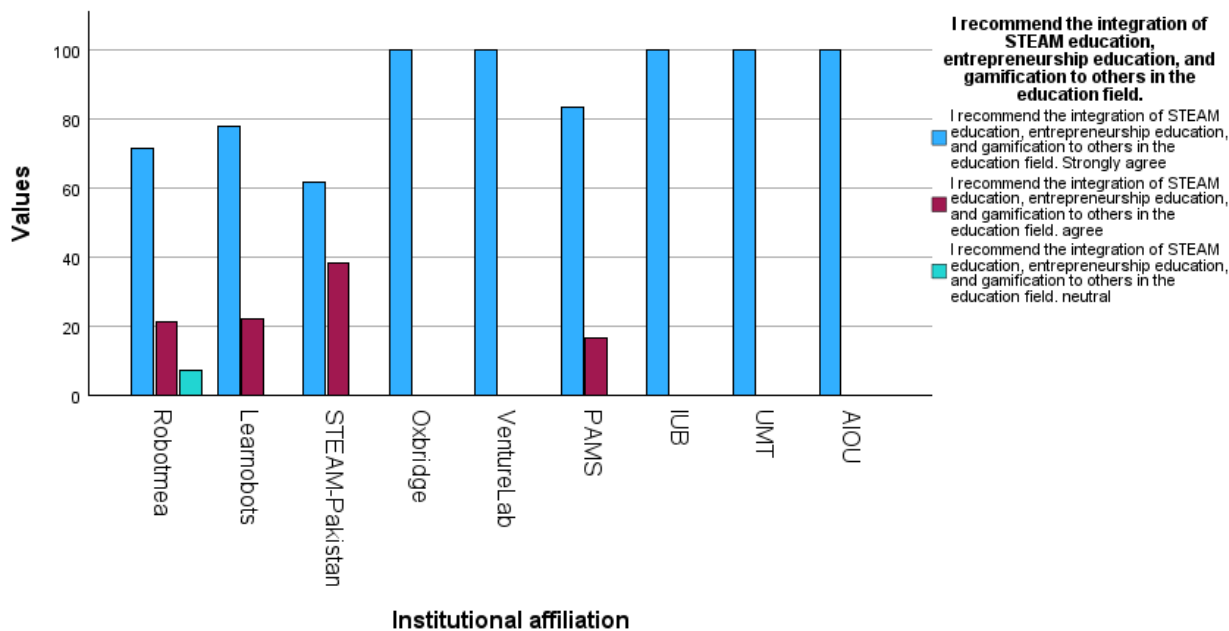

Figure 8

In contrast with the pattern of above responses, the current practice of integration is neutral to no in different educational

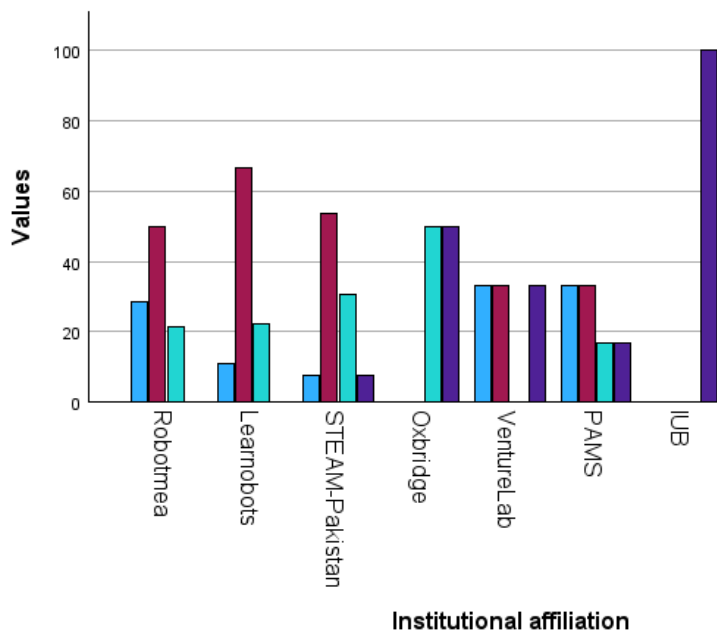settings which once again signifies the making of the intended framework (Figure 9).

The discussion section addresses these points and discusses the results in detail. It talks about TPACK's role in entrepreneurship education by bringing STEAM into play. It explores participants' perspectives, teaching practices, challenges, and professional development needs, and has implications for future research and teaching opportunities. Additionally, curriculum developers and educators can use the TPACK framework to develop guidelines and tools to support the successful integration of business learning and STEAM using Android in a variety of learning domains (Belda-Medina, & Calvo-Ferrer, 2022).

The results of this study support the use of the Technology Content Learning Knowledge Framework (TPACK) as a guide for introducing enterprise learning through games into STEAM. TPACK emphasizes the intersection of technical knowledge, instructional strategies, and specific content knowledge. Integrating training into the STEAM curriculum requires educators to fully understand how these three components interact and influence each other. The TPACK framework allows educators to use technology tools, learning styles, and company content knowledge to create meaningful and meaningful learning experiences for students (González-Pérez, & Ramírez-Montoya, 2022).

To what extent entrepreneurship education is advocated by m Institutional affiliation Crosstabulation...

Figure 9

5. DISCUSSION

According to the survey results, the majority of respondents understand the value and benefits of incorporating vocational

training into STEAM through gaming. Participants agreed that motivational factors such as problem-solving, simulation, and competitive situations increase student engagement and motivation. 50 participants argued that STEAM user training is integrated by promoting a holistic learning approach that encourages creative thinking, collaboration, and learning. The participants' responses showed the importance of incorporating learning methods based on TPACK in order to effectively integrate educational benefits through STEAM games. Educators know how to integrate multimedia and technology resources with unique instructional design and content knowledge. Educators using the TPACK framework can enhance their students' entrepreneurial skills in STEAM by using a variety of technology tools such as virtualization, interactive platforms, and analytics. TPACK effective learning activities provide educators with a structured approach that promotes reflective learning that includes hands-on, problem-solving, and hands-on activities.

The research findings also show the challenges and professional development needed to integrate business learning through games with STEAM in TPACK. Participants identified issues such as limited access to technology resources, learning how to use specialized equipment, and the need for continuing professional development to develop TPACK skills. To meet this challenge, organizations and policymakers must invest in technological infrastructure, provide opportunities for technological development, and develop an environment that supports experimentation and collaboration.

6. CONCLUSION

Future research based on the findings of this study could identify different approaches and best practices for integrating entrepreneurial learning and STEAM through TPACK games. It is also important to understand the impact this inclusion has on student entrepreneurship, STEAM learning, and motivation. Longitudinal studies could also investigate the long-term effects of integrating STEAM with entrepreneurship education through playful and hands-on skills, creative thinking, and problem-solving skills. Curriculum designers and educators can also use the TPACK process to develop evidence and materials to support the successful integration of industry and STEAM education through educational games.

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