

Exploring the Transformative Influence of Student Innovation Competitions and Programs: Insights from their Organizers

Fay Berig, Sadan Kulturel-Konak and Abdullah Konak
fjb5263@psu.edu, sxk70@psu.edu, auk3@psu.edu

Abstract - Student innovation competitions and programs have gained substantial recognition as the number of students entering science, technology, engineering, mathematics, entrepreneurial, and business fields continues to increase. Student participants, mentors, organizers, and faculty members see these competitions and programs as catalysts for fostering creativity, initiative, and entrepreneurial spirit. Innovation competitions and programs augment the problem-solving skills and creative abilities of many participating students and mentors. Participating in these competitions and programs leaves students with many important skills that will benefit them in their entrepreneurial futures. Such skills include creativity, leadership, problem-solving, and more. Drawing insights from interviews with experienced organizers of innovation competitions and programs, this article outlines the skills that students gain from their participation in these programs.

Keywords— *Entrepreneurship, Innovation Competitions and Programs, Organizers, Student Skills*

I. INTRODUCTION

Innovation has been and continues to foster the drive for entrepreneurial progress within society. Student innovation competitions and programs (ICPs), such as business plan competitions, hackathons, etc., provide a platform for participants to gain personal, professional, and educational skills while allowing them to tackle real-world problems. Organizers, in particular, allow innovative skills and practices to flourish within controlled environments such as innovation and pitch competitions, hackathons, and startup events. These competitions and events created and run by organizers benefit those participating, such as students, staff, and mentors, by allowing them to break routines, encourage creativity, and strengthen skill sets [1]. Many colleges and universities are home to diverse populations of students with different backgrounds. These students offer a myriad of differing viewpoints, ideas, and problem-solving abilities that allow for the cultivation of creativity, teamwork, and critical thinking skills [2]. ICPs also allow students to gain exposure and experience in different fields. This allows students to nurture their work abilities, as well as develop problem-solving methods based on the information they have learned [2]. Participation and cooperation in ICPs greatly impact students' innovative skills by encouraging the integration of outside knowledge and

experiences [3]. Overall, ICPs provide many opportunities, benefits, and skills to participants.

Organizers play an important role in ensuring the success and outcomes of running such events, competitions, and programs. The efforts, considerations, and best practices of organizers play a crucial role in the advantages that students gain through participating in ICPs. Consequently, this paper analyzes interview data from experienced organizers to determine the skills students gain through their participation in ICPs. Based on their experience, the organizers were asked what the most important skills and knowledge that students gain from participating in these student innovation programs and competitions are.

II. LITERATURE REVIEW

A. Introduction

This literature review analyzes classifications of ICPs, such as their benefits for students, short and long-term competitions, how they allow learning from past failures and mistakes, the involvement of organizers, and lastly, hackathons. These classifications showed dominant common characteristics and data while researching the benefits that students gain from participating in ICPs. It is important to understand how different types of competitions and programs, such as short and long-term hackathons, differ in their benefits to participants. These classifications are important in the role they play in understanding how specific competitions, skills, and resources allow students to flourish in their involvement in ICPs. The involvement of organizers allows for an insight into their best practices and efforts to ensure a successful program and to better understand what skills and benefits students gain from an organizer's point of view.

B. Benefits for Students

Many organizers of ICPs tend to encourage entire university campuses to get involved in these competitions and events, regardless of students' majors or fields of study, as this practice aims to increase overall entrepreneurship across universities [1]. Such competitions and hackathons allow like-minded individuals to come together in a safe environment and improve their teamwork and networking skills by conversing and working with people who share the same ideas and goals [3]. According to [4], research has shown that a supportive community and structured competition allow participants to

strive and strengthen their innovative skills. ICPs set a drive for participants that encourages the development of creativity while maintaining a controlled and productive environment [5]. Kulturel-Konak et al. [6] clarified the meaning of gaining “innovative skills” as the ability to develop new and original solutions to problems. Many ICPs require outside-of-the-box thinking, creating a risk-friendly environment that fosters creativity in participants [4]. With innovative thinking skills, student participants also develop entrepreneurship skills. Entrepreneurship skills allow participants to bring their innovative ideas to life [7].

While many attributes, such as taking initiative and keeping your team afloat, contribute to important leadership skills, being a leader mostly resembles the process of character development throughout a competition [8]. Such competitions allow participants to test their ideas by gaining valuable feedback from peers and professionals [9]. Participants are also more likely to gain exposure to real-world experiences by solving real cases and problems. ICPs provide a myriad of opportunities for students to demonstrate their talents [9]. By doing so, participants open doors for opportunities such as gaining internship positions and achieving other educational and professional goals [9]. Increased exposure to the format of many ICPs, especially those focusing on engineering that follows the design, build, and test cycles, allows students to gain more experience with real-life engineering experiences [10]. The increase in such personal fabrication skills tends to attract more employers searching for students with hands-on experience [10].

Table I outlines the different skills participants may gain from participating in ICPs. Although there are many benefits from participation, research suggests that creativity, teamwork, problem-solving and decision-making, networking, business and innovation, learning from failure, and leadership skills are the primary and most significant skills that will stick with participants and aid them in real-life scenarios.

TABLE I
SKILLSETS GAINED IN ICPs MENTIONED IN THE LITERATURE

Skillsets	Resources
Creativity	[1, 3-5, 11]
Teamwork	[3, 5, 7, 9, 11, 12]
Problem-Solving/ Decision Making	[7, 9, 11-14]
Mentoring/ Networking	[1, 3, 15, 16]
Business and Innovation	[1, 3, 15, 16]
Leadership	[9]
Learning From Failure	[9, 13, 14]

C. Short-Term and Long-Term Competitions

While structured competitions, in general, offer opportunities for participants to flourish and showcase their skills, they are grouped into two separate categories: short and long-term competitions [4]. Both formats offer support and motivation for participants to expand on their ideas. Long-term competitions can last longer than two months, while short-term competitions tend to last about a week or even less [4]. An organizer's role in long-term competitions consists of mostly offering participants

structured guidance, resources, and support, whereas, in short-term competitions, organizers aim to provide motivation through their innovative journeys [4].

D. Learning From Failure

A key characteristic of successfully organized ICPs is materializing innovative ideas to remain relevant in the current market and face evolving challenges in today's business, social, and environmental sectors [13]. Many organizers running ICPs need to account for the possibility of failure and recast it into a learning experience for many eager participants going forward. Even if they do not win, participants have dedicated their time and effort to learning and growing within enriching and stimulating environments, allowing them to apply their knowledge to tackle a problem [9]. Buchal [11] also suggests that in some hands-on engineering challenges, participants may often not achieve the results they want due to mechanical failures. However, these participants can gain valuable learning experiences from these failures and use these results to improve future designs. It is also important for participants to gain an understanding of and become familiar with testing their design processes [11]. Organizers also need to dedicate time for participants to get comfortable changing their daily routines and practices. Innovation requires participants to climb out of their comfort zone in order to overcome specific challenges and obstacles [14].

E. Involvement of Organizers

We also look at the best practices for organizers to follow when running ICPs. It is recommended that organizers use and contribute to their participants' success and entrepreneurial mindset growth by offering a hands-on curriculum, a holistic and heterogeneous approach, a challenging and stimulating environment, unconventional but realistic expectations, and by offering a multitude of opportunities for networking and collaboration with experts and academics [15]. It has also been found that integrating a high level of entrepreneurial accelerators and programs, such as networking events and programs will benefit such participants with an innovative mindset throughout ICPs [15]. Organizers also view connecting students to university-provided resources as an objective of successful ICPs [17]. Many organizers consider ICPs as platforms for student participants to connect, collaborate, and celebrate their achievements [17]. Further research suggests that students who have previously participated in such competitions reported that teamwork, imagination, and entrepreneurial skills are all factors that determine winners of innovation challenges [12].

F. Hackathons

Although deemed similar, hackathons have some differences from other typical ICPs. In general, many organizers and organizations run hackathons to allow participants to come together to generate ideas, develop prototypes, and test new products and services [18]. Organizers also motivate these participants to attend and engage in ICPs to grow and develop their entrepreneurial skill set [19]. Hackathons also nurture and promote the introduction of new ideas and allow participants to

explore a variety of approaches with a positive working environment within their teams and communities [7].

III. RESEARCH METHODOLOGY

A. Creating Interview Questions & Interviewee Selection Procedures

This study used a qualitative research methodology that collected responses from different organizers of ICPs across universities within the United States through interviews. The organizers interviewed are representatives of several different higher education institutions across the United States, who have had previous experience in organizing and running ICPs.

This research project involved three stages. Firstly, we reviewed existing literature on ICPs, with a focus on the perspective of organizers. We classified the literature and identified the skills and benefits of participating in such competitions. We then established interview questions to address further findings from this literature review. Next, the researchers developed interview questions to explore organizers' perspectives, and we conducted interviews with 31 organizers with previous experience with student ICPs. We collected data on their involvement and experience. Finally, we transcribed the interviews and analyzed the data.

Interviewees for this project are from universities such as Pennsylvania State University, Oregon State University, Cornell University, Lehigh University, Temple University, West Virginia University, and many others. Aside from sending emails to potential organizers, opportunities to participate or be interviewed were announced at multiple conferences. Whoever responded to our emails or showed interest in being part of this study was further interviewed and asked a series of questions to gain their insight on student ICPs. Out of the 31 organizer interviews, roughly 55% (17) identified themselves as female and 45% (14) as male. When the interviewees were asked about their experience in organizing student ICPs, approximately 70% (22) of interviewees had more than 6 years of experience, 20% (6) had 3-5 years of experience, and 10% (3) had less than 2 years of experience.

The research team conducted interviews remotely via video conferencing through Zoom. The interviews were conducted independently at predetermined times and lasted between 20 to 40 minutes. Informed consent was secured, and the interviews were recorded in Kaltura, and the transcripts were produced through Kaltura's automated system. To ensure the accuracy of the transcripts, we cross-checked them with the original video recordings whenever necessary. The interview transcripts were organized and categorized by specific questions in preparation for their upload into NVivo, a qualitative data analysis software.

B. Analysis of the Responses

The main goal of the analysis was to identify the perceptions of the organizers and what types of skills and abilities students gain through ICPs. Therefore, we analyzed the responses to the interview question: "Based on your experience, what are the most important skills and knowledge that students gain from participating in your Innovation Competitions and Programs (ICPs)?" in this paper. We used a grounded theory approach [20]

to analyze the interview transcripts. In the first phase, we reviewed the interview transcripts and employed an "open coding" technique without considering a theory to identify distinct codes recurring in the transcripts, as given in Table II. After the 25 distinct codes were determined, three members of the research team independently went through the transcripts to determine whether each code was present or not in the transcript. The three codes were combined together, and the inter-rating agreement among the independent raters was calculated using the Fleiss Kappa function in R. The resulting Kappa value was $Kappa = 0.495$ with $z = 23.9$ and $p = 0.0$, indicating a moderate, statistically significant agreement among the raters.

TABLE II.
CODES AND RELATED BROADER THEMES OF THE SKILLS

Adaptability and Resilience
Ability to operate with uncertainty
Handling changes or unexpected circumstances
Learning from failure
Ability to pivot
Communications
Answering questions
Having a strong pitch
Presentation skills
Public speaking and communication skills
Domain-specific Skills
Gaining knowledge
Exposure to different skills
Entrepreneurial Skills
Building business models
Customer discovery skills
Learning what entrepreneurship is and adding it to their curriculum
Understanding process and utilizing product management tools
Networking
Feeling that they belong
Making connections
Personal Development
Building confidence
Having a growth mindset
Learning how to take criticism
Problem-solving
Problem-solving skills
The ability to construct an argument
Understanding and solving real-world problems
Teamwork
Comfortable with asking for help
Leadership skills
Teamwork skills

In the next phase, two research team members analyzed the codes and transcripts and grouped the related codes to form broader themes of skills, as given in Table 1, using a consensus approach. In the next stage, we calculated the number of times that the themes were mentioned by the organizers to investigate the relative importance of the broader skills and the frequency with which the themes were mentioned together by the same organizer to understand the relationships among the themes. As seen in Figure I, all skills mentioned by the organizers are closely related to one another.

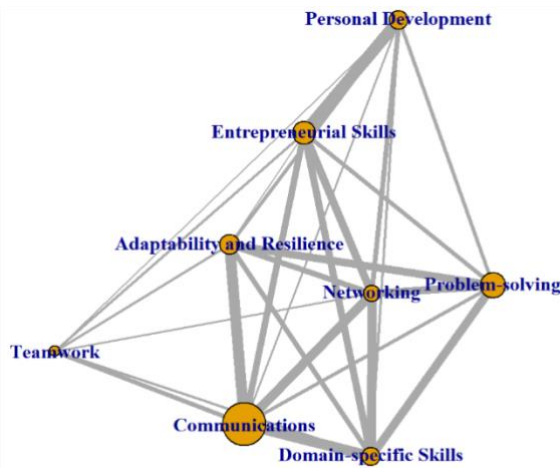


FIGURE I
THE RELATIONSHIP NETWORK AMONG THE EMERGING THEMES

IV. FINDINGS AND DISCUSSIONS

In the following, we explain the conceptual definitions of the emerging theme and their implications related to ICP participation.

A. Adaptability and Resilience

To discover novel solutions to the complex problems of today, we must explore unexplored paths and adopt unconventional methods. Therefore, the ability to handle uncertainty and effectively perform ambiguous tasks is critical to turn innovative ideas into reality. In addition, risk assessment is an important component of all entrepreneurial mindset frameworks [21]. In this study, the Adaptability and Resilience theme indicates an initiative-taking and positive approach to dealing with uncertainty, learning from experiences and failures, and pivoting when needed. One organizer mentioned that “Everything is associated with the entrepreneurial mindset, right? So flexibility, adaptability,” and another stated, “.... there's a lot of ambiguity in where the initiative is headed in terms of projecting where they want to be six months from now and even the bigger picture vision of where they want to go. So kind of operating in that environment of..I don't know what I don't know at this point. And a lot of uncertainty goes with that. That is kind of a unique set of skills that they acquire as well. Just the ability to operate with limited certainty in the environment that they're operating in.”

B. Communications

Based on the organizers' responses, the Communication theme indicates skills and competencies to convey ideas persuasively and responsively. This theme encompassed the most frequently mentioned skills by the organizers, and they emphasized the dynamic nature of the communications, including understanding questions and engaging with diverse audiences. The organizers clearly observed that students improved communication skills that are difficult to master in a regular classroom setting. One organizer mentioned, “...in terms of skills, that would be taking the abstract that you often see in entrepreneurial ventures and making it concrete to present to their audience. The second

would be presentation skills, both in terms of slide design and also presenting. Then the third is comfort level with Q&A ...”

In Figure I, it appears that the communications theme has a direct and possibly strong relationship with all other emerging themes in addition to being the most frequently mentioned skill, emphasizing its central role in professional and personal development through ICPs.

C. Entrepreneurial Skills

Entrepreneurial Skills encompass many diverse types of skills, dispositions, and knowledge, including other emerging themes. In this study, Entrepreneurial Skills refer to competencies in creating business models and testing those models through a customer discovery process. One organizer mentioned, “...most of the students involved in this are not in the business school. And so they're learning about customer discovery. They're learning about some of the vocabulary of business. And the third thing is they're learning how to develop priorities for their viable product. That is not just about technical demonstration, it's also about understanding the product in the context of the user...”

D. Networking

Networking skills involve creating a sense of belonging and making meaningful connections within professional or social contexts, which includes initiating and maintaining relationships, building rapport, and effective communication, ultimately contributing to a supportive and collaborative network. During our interviews, one organizer mentioned, “... they're also learning how to network and have side conversations ...”, another said, “I would say the thing that makes the difference for us is we prioritize inclusion. So those students are finding themselves as entrepreneurs regardless of their background. And because we prioritize those things, I would say what students learn is that they do belong here. If they want, if they want to pursue entrepreneurship, there is a space for them...”

E. Personal Development

Personal development involves intentionally building confidence, cultivating a growth mindset, and learning to handle criticism effectively. Our interviewees also mentioned fostering confidence, embracing a growth mindset [6], and navigating constructive criticism, a few examples are as follows: “The first thing is confidence, watching them transform. And a lot of it has to do with maturity because a lot of them will come to us as freshmen, you know, 18 years old. And we'll work with them all the way through grad school and sometimes even beyond grad school. And so that as they mature, that confidence develops too. It takes guts to ask for help because a lot of people don't want to admit that they need help. And that's a big change that I see along with that, just that maturity and competence.” “Accepting critique and using that as a way to get better rather than saying that must mean it's a terrible idea. And ability to look at the landscape of ideas that are out there and be able to articulate what's different about yours...” “...growth mindset for sure...”

F. Problem-solving

Problem-solving requires skills in constructing persuasive arguments to address real-world issues. It involves analyzing, evaluating, and devising effective solutions. This skill set involves identifying challenges and constructing well-reasoned arguments during the problem-solving process, ensuring a systematic approach to addressing real-world problems. One organizer mentioned, “*We're primarily problem-solving ...*” and the other organizer stated, “*...ultimately what I think happens is those that tend to perform the best start to identify that, by clearly communicating a small part of that big problem becomes an actual valuable contribution...*”

G. Teamwork

Teamwork involves individuals collaborating within a group, seeking assistance when needed, having good leadership skills, and contributing to the team's goals. It requires a balance of humility and leadership where individuals are comfortable asking for help and able to lead and work with others effectively. Most organizers whom we interviewed mentioned teamwork skills, e.g., “*... I think it's, it's really a matter of learning from each other, working, working together, learning how to again help each other while still also maintaining that competitive spirit ...*” “*... there's some leadership qualities that they can learn for sure ...*” And another organizer mentioned, “*Every single individual and the team have different skills that collectively contribute.*”

CONCLUSIONS

By conducting interviews with 31 organizers, we recognized the benefits and skills students gained by participating in ICPs through their perspectives and experiences. This study used an interview-based and qualitative research methodology to address a gap between firsthand interviews and primary data illustrated in many papers used in the literature review. By analyzing the 31 organizer interviews, we determined the skills gained and benefits of student participation in ICPs. Such skills included Adaptability and Resilience, Communications, Domain-specific, Entrepreneurial, Networking, Personal Development, Problem-solving, and Teamwork. These skills often evolve into neighboring and related skills that enable students to showcase their abilities in other contexts. Oftentimes, students will portray these newly gained skills, knowledge, and abilities in real-world situations. This is beneficial in not only professional settings but also in many non-formal situations. Therefore, we can conclude that observing the outcomes of ICPs from the lenses of organizers allows us to gain a better understanding of the success of running competitions and programs that will benefit students in the long run. Future research will include a thorough analysis and comparison of mentor and student perspectives on the benefits and skills students gain from participating in ICPs.

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AUTHOR INFORMATION

Fay Berig, a second-year student at Pennsylvania State University, Berks.

Sadan Kulturel-Konak, Professor, Management Information Systems, Division of Engineering, Business and Technology, Pennsylvania State University, Berks.

Abdullah Konak, Distinguished Professor, Information Sciences and Technology, Division of Engineering, Business and Technology, Pennsylvania State University, Berks.