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Work-In-Progress: Engineering Entrepreneurial Mindset Through Informal Learning: A Case Study of EM Integration in Hackathons and Makeathons

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WIP: Engineering Entrepreneurial Mindset (EM) Through Informal Learning - A Case Study of EM Integration in Hackathons and Makeathons

Abstract

The integration of Entrepreneurial Mindset (EM) into formal learning spaces has been well documented in scholarly literature. However, its use in informal learning spaces, such as hackathons and makeathons, remains limited. Hackathons and makeathons are high-impact informal learning environments that foster innovation, collaboration, and rapid problem-solving among engineering students. To address the gap, OHI/O, an informal learning program at The Ohio State University in the United States, implemented a series of EM-based interventions across multiple hackathon and makeathon events. These interventions included the development of an EM-aligned competition rubric, supporting materials and training, and a capstone track to link formal and informal learning. These implementation efforts were captured in detail in a previous publication. This work-in-progress (WIP) paper builds on the results of the prior publication [1], a mixed-method study, scheduled for completion in summer 2026, and captures important adjustments implemented based on earlier feedback. Interim quantitative results indicate a consistent pattern in which students rate themselves more favorably than judges across all rubric dimensions, with variations across event types and project categories. Qualitative thematic analysis of student video presentations from Makeathon 2025 and Hackathon 2025 reveals three primary themes aligned with EM constructs, with new sub-themes emerging in the most recent events. The current work, which explores hackathons as a potential exemplar for cultivating EM, could serve as a model for how informal learning spaces can enhance student engagement and reinforce learning objectives related to EM.

Introduction

Informal experiential learning environments such as hackathons and makeathons offer beneficial learning practices for engineering students outside their formal classroom activities. These events provide students with the opportunity to engage in co-curricular or extracurricular active, informal, experiential learning events [2]. Literature suggests that hackathons promote skill development by engaging students in activities that foster peer collaboration, teamwork, and experiential practices [1], [2], [3], [4]. During these events, students collaboratively solve real-world problems within a limited time frame (e.g., 24 hours - 48 hours) [4], [5]. Such events allow students to apply their technical knowledge while addressing real-world challenges and developing interpersonal skills that are valued by industry [3]. Additionally, hackathons and makeathons are known to equip students with practical experience and improve career readiness by fostering skills such as communication, critical thinking, and problem-solving [6], [7].

Despite hackathons and makeathons' potential for skills development, there is limited literature that provides specific insights into how such informal learning events support the development of Entrepreneurial Mindset (EM) [1]. In response, OHI/O, an informal learning program at The Ohio State University (OSU) in the United States, implemented a series of EM-based interventions across multiple hackathon and makeathon events [1].

One prominent approach for advancing EM within engineering education is provided by the Kern Entrepreneurial Engineering Network (KEEN). KEEN's mission is to "graduate engineering students with an EM so they can create personal, economic, and societal value through a lifetime of meaningful work" [8]. The KEEN EM framework outlines structured pedagogical practices and strategies that engineering educators can use to guide students systematically as problem-solvers. The framework pairs engineering skills with EM and its outcomes [9]. Elements of these outcomes can be mapped to those of the Accreditation Board for Engineering and Technology (ABET) student outcomes [10], which broadly encourages programs to build students' ability to learn, explore, incorporate, and apply knowledge from technical and non-technical domains to produce impactful solutions to real-world problems.

This Work-In-Progress (WIP) paper is a continuation of a previous study [1], which examines the extent and ways in which EM is exhibited over the series of hackathon events, and presents interim results, observations from adjustments made in response to feedback, and discusses next steps at the completion of the long-term project.

Background

Informal learning supports the development of EM by immersing students in experience-based, social contexts that emphasize exploration, reflection, and adaptation. Sefton-Green characterizes informal learning as an experience in which learners develop understanding through participation, interaction, and meaning-making rather than through structured instruction [11]. Hackathons have been widely documented in scholarly literature as high-impact learning environments that foster rapid problem framing, collaboration, and applied creativity [4]. These characteristics position hackathons and other informal learning spaces as particularly relevant contexts for examining the development of EM.

KEEN has emerged as a prominent collaborative network dedicated to cultivating EM among engineering students in the U.S. [8]. The network now has more than sixty partner institutions across the country [12]. The KEEN framework is anchored by the 3Cs of EM: Curiosity, Connections, and Creating Value, which serve as the foundational pillars for cultivating entrepreneurial thinking in engineering education [9]. Curiosity represents the fundamental drive to investigate a rapidly changing world [9], [13]. Connections address the reality that discoveries and information alone are insufficient for meaningful innovation [9], [13]. Creating value emphasizes that innovative solutions are most meaningful when they create benefits for others [9], [13]. The framework extends beyond these three core mindset dimensions to encompass additional educational outcomes, categorically Collaboration, Communication, and Character, characterizing Entrepreneurially Minded Learning (EML) [14].

Building on KEEN's EM framework, the research team in this paper performed a pilot application of the KEEN 3Cs framework within the OHI/O informal learning program [1], [15]. OHI/O is a student-led initiative responsible for organizing the hackathon and makeathon events at OSU [15]. The hackathon and makeathon events were selected because they are recurring, large-scale, institutionally supported, student-led, and consistent, and provide a stable platform for cross-event comparison while preserving the authenticity of the informal learning ecosystem. Despite differences in technical modality, both events share the same structure. Teams form around self-identified ideas, work intensively for 24 hours, and present their prototypes to external judges for feedback. The consistency in event format and open-ended challenge creates comparable learning conditions. The core challenge evaluated in this study remained intentionally broad and consistent across all events examined. While individual events were organized around themes related to tools of production, such as hardware-focused (makeathon) or software-focused (hackathon), the central directive that the teams evaluated in this study chose to address the Open track, where they were prompted to "build anything." This structure was maintained consistently across pre- and post-intervention events.

This initial implementation effort was comprehensive, including the development of an EM-aligned competition rubric. The rubric systematically mapped traditional hackathon judging criteria to OSU's College of Engineering's learning outcomes and the KEEN EM framework's core dimensions. The rubric reorganized legacy judging criteria around six core values: innovation, curiosity, communication, project breadth and complexity, impact, and navigating challenges. Complementing the rubric, revised participant guides, judge guidelines, and mentor handbooks were developed to communicate consistent expectations, provide guidance on fostering EM attributes throughout the hackathon and makeathon experience, and ensure consistent application of the rubric. Additionally, a five-unit EM student leadership training series was implemented to equip student leaders with the mindset and practical understanding necessary to design and promote EM-infused competitions. A dedicated capstone track was also introduced, bridging formal coursework with the informal learning environment by creating a space for students enrolled in a capstone course to prototype and refine course projects during events.

Adjustments based on Initial Implementation Feedback

Feedback from the initial implementation highlighted areas for refinement to strengthen the overall consistency and reliability of the hackathon experience. While judges were highly committed and enthusiastic, feedback indicated that additional structure was necessary to support clarity, confidence, and consistency in the judging process. In response, judge training was revised to be more applied and practice-oriented. Training materials were updated to include concrete examples of past team projects, enabling judges to better ground the abstract rubric criteria in realistic project contexts and encourage rubric-aligned evaluations.

Growth in participation from industry professionals also necessitated changes to the judge selection process. As interest in volunteering as judges rapidly grew, challenges emerged regarding the quality of feedback and the dynamics of the judging group. To address these concerns, the judge acceptance model transitioned to a more selective, application-based process. Prospective judges were required to complete an application, with priority given to those able to participate in person and serve as both judges and mentors. Judges unable to attend in person were still permitted to apply by submitting a video in which they evaluated a sample project using the official rubric and provided actionable, constructive feedback.

Finally, revisions were made to the reflection questions included in hackathon project submissions. Analysis of these reflections revealed a disconnect between some teams' performance scores and their self-evaluations, particularly among teams participating in sponsor-led challenges. To encourage more intentional and honest self-assessment, the reflection language was revised to emphasize the importance of aligning reflections with scoring criteria and to clearly state that these self-assessments would be used for program improvement. Together, these adjustments reflect an effort to strengthen alignment, authenticity, and learning outcomes across the hackathon experience.

Methods

This study uses a mixed-methods research design to examine the effectiveness of EM interventions implemented in hackathon and makeathon events. It integrates qualitative and quantitative evidence to provide a comprehensive understanding of student learning and program impact. Mixed methods designs are recommended for educational and intervention research when quantitative measures of change, such as rubric scores or survey ratings, need to be complemented with qualitative data [16], [17]. Participants in the research included student teams, with two to four students from a range of engineering majors and class years, and volunteer judges from academia and industry. In addition, there were mentors who supported the teams throughout the events. Data sources included student presentation videos, student self-reflection surveys, judges' rubric-based scores and written feedback, mentor and judge surveys about experiences with the intervention, and instructor feedback on capstone team participation and performance. Student presentation videos were transcribed and analyzed using thematic analysis [18]. This qualitative analysis helped identify patterns in how students described their problem framing, design decisions, and engagement with EM constructs. The following sections highlight the data analysis processes used in this study.

Quantitative Data Analysis Process

Quantitative data from student self-assessments and judges' evaluations were analyzed to characterize students' and judges' views of assessed performance. Performance was evaluated across rubric dimensions to compare student and judge ratings. Engagement trends were also captured across events and participation groups. At the current stage, the quantitative findings are presented on a broader level, using descriptive statistics. These results were intended to provide contextual grounding for the broader qualitative investigation. Accordingly, the quantitative analysis was limited to categorical and global competition averages, standard deviations, categorical frequency counts by rating, and differences are based upon the averages. These are used for preliminary comparisons rather than inferential conclusions and definitive claims. In the current stage, no statistical inter-rater reliability analysis has been conducted. Therefore, the extent of shared interpretation of the rubric between judges or between student groups has not been statistically established. A more rigorous reliability analysis is planned for the subsequent phases of this study to characterize the performance of the rubric. Correspondingly, unless a team has participated more than once, judges' feedback does not impact student narratives extracted from the student presentation videos.

Data selection for Video presentations

The data selection process for the Open Track student presentation videos included reviewing the judging rubric and scores for project teams and organizing and sorting the scoring data in an Excel spreadsheet. Data was drawn from the Makeathon 2025 and Hackathon 2025 events. Each of these events included the judges' quantitative scores assigned to each team using the EM-based judging rubric. This revised rubric included six criteria or categories: Innovation, Curiosity, Communication, Project Breadth and Complexity, Impact, and Navigating Challenges. Each category was scored on a 5-point scale. For each team, the average scores of all six rubric criteria were calculated and documented in separate event spreadsheets. The total average scores were further sorted into three categories: high, medium, and low. As the data was normally distributed, +/- 1 standard deviation was used to define the limits for high (> +1 σ), medium (+/- σ), and low (< -1 σ). After sorting the average scores of the teams into the three categories, the teams from each category were inserted into an online randomizer list. This randomizer generated a random list of four teams for each category. This resulted in 12 teams being randomly selected for the Makeathon 2025 event. This process was repeated for the Hackathon 2025 data as well.

Qualitative Data Analysis Process

Based on the data selection process, 12 Open Track student video presentations were extracted from each event for transcription. Each video ranged in duration from 2 to 4 minutes. Including Makeathon and Hackathon data, a total of 24 video presentations were transcribed using an online, real-time transcription service, Otter.ai [19]. A prior thematic analysis was conducted during the initial implementation, identifying themes and patterns in the previous makeathon and hackathon dataset. Three primary themes were identified: Theme 1: Motivation and Opportunity, Theme 2: Design and Application, and Theme 3: Impact and Growth. Each primary theme included sub-themes. For theme 1, four sub-themes were identified: Problem Identification, Context, Benefits, and Novelty. For Theme 2, three sub-themes were identified: Challenges, Design Considerations, and Implementation. Lastly, for Theme 3, two sub-themes were identified: Impact (personal or societal) and future work. Since inductive thematic analysis was used in the prior implementation publication, the authors adopted a deductive approach to the transcribed video data from Makeathon 2025 and Hackathon 2025.

Given that the goal of this WIP paper is to extend, refine, and continue testing an existing implementation of an EM-infused intervention in informal spaces such as hackathons and makeathons, a deductive thematic analysis approach is best suited for this stage of the study [20], [21], [22]. The analysis included using the existing themes from the previous paper [1]. The authors reviewed and revisited the definitions for each of the previous themes and their associated codebooks. The analysis was carried out in NVivo 14 qualitative analysis software [23], where the transcribed data from Makeathon 2025 and Hackathon 2025 were uploaded. The authors repeatedly read through the transcribed data to familiarize themselves and coded based on existing themes. After the initial coding, the authors reviewed the data again to explore new themes or codes. The existing themes and the newly identified themes were documented and revisited for further discussion and iteration. After all authors deliberated on the list of themes, they were synthesized and refined.

Results

This section discusses the results of this WIP in two sections: quantitative and qualitative. The relationship between quantitative and qualitative results is contextual at this stage, and any suggested relations are subject to further investigation, based on the next (and final) round of data collection in Spring 2026.

Quantitative Results

The current data set consisted of 326 student teams and 1351 judges' entries. Approximately 60% (195) of the 326 teams were open track projects, with the remaining 40% (131) being industry partner- or OHI/O-derived challenges. The data also indicated that many teams have at least one returning participant (176 of 326 teams), and 15 teams were identified as entering a project directly related to a capstone course.

Students generally viewed themselves as "accomplished" or "advanced" (a 5 or 4 out of 5 on the rubric scale) in curiosity, communication, impact, and navigating challenges. Students were less clustered in their self-assessments of innovation, project breadth, and project complexity. In comparison, across all competitions, judges appeared to rate students most strongly in the communication category ("accomplished" to "advanced"). In all other categories, judges generally clustered around "advanced" and "intermediate" (a 4 or 3 out of 5 on the rubric scale) with varying differences in spread within each category. When looking at all student team self-assessments and judges' ratings across all competitions, students, on average, perceived themselves as performing better than the judges' average ratings in all categories. Table 1 below shows differences between students' and judges' ratings by category for each competition and overall. In Table 1, this data is presented without regard to project type (i.e., open track projects vs. challenge projects). Next, Table 2 shows differences limited to the same scope as the qualitative analysis, which examines open track projects only.

Table 1: All Student Teams vs Judges

	2024 Hackathon Student to Judge Differential	**2025 Makeathon Student to Judge Differential**	**2025 Hackathon Student to Judge Differential**	**Grand Average (across the whole dataset for the category)**
Innovation	0.64	0.77	0.73	0.69
Curiosity	0.86	1.02	0.70	0.82
Communication	0.62	0.80	0.50	0.61
Project Breadth and Complexity	0.74	0.76	0.70	0.72
Impact	0.93	0.95	0.96	0.95
Navigating Challenges	1.03	1.21	0.83	0.98

Table 2: Differentials for Open Track Projects Across Years and Events.

	2024 Hackathon Student to Judge Differential	**2025 Makeathon Student to Judge Differential**	**2025 Hackathon Student to Judge Differential**	**Grand Average (across whole dataset for the category)**
Innovation	0.68	0.94	0.71	0.72
Curiosity	0.87	1.19	0.62	0.79
Communication	0.66	0.87	0.45	0.60
Project Breadth and Complexity	0.84	0.80	0.61	0.72
Impact	0.88	0.92	0.83	0.87
Navigating Challenges	1.09	1.08	0.76	0.95

Without regard to project type, differences range from approximately 1.2 to 0.50 in favor of students' more positive perception of their performance. This changes only somewhat when examining only open track projects. Regardless, on average, students and judges showed the most agreement, that is, the least gap in innovation, communication, breadth, and complexity, and less agreement in terms of curiosity, impact, and challenges. This is particularly of interest when considering the extent to which students elicit certain themes more strongly.

When comparing the Hackathon 2024 and Makeathon 2025 events, gaps widened. However, while comparing Makeathon 2025 to Hackathon 2025, gaps decreased or remained nearly the same. Quantitative observations of the hackathon and makeathon events revealed variations across the two contexts. The significance of these variations is a subject of further analysis.

Similar to previous documented stages of the study, the quality of the student self-assessment data was examined, particularly as an indicator of engagement with the rubric. Thus, the authors continued to monitor student teams that self-assess uniformly as “accomplished” in all areas, at this time totaling 79 of 326 teams. Across the Hackathon 2024, Makeathon 2025, and Hackathon 2025 competitions, authors saw 27, 10, and 42 teams self-assess as “accomplished” in all categories, respectively. In addition, 45 of 79 (57%) came from independent projects, and 34 of 79 (43%) came from industry challenges. Removing both student self-assessments and judges’ ratings that indicated uniform achievement of “accomplished” reduced the average gap between student teams and judges.

Qualitative Results

Thematic analysis of the Makeathon 2025 and Hackathon 2025 transcribed data revealed new sub-themes for each of the three high-level themes. Some of the existing sub-themes from the initial implementation’s thematic analysis were revised, recategorized, and redefined for better alignment and clarity.

Theme 1: Motivation and Opportunity

This theme captures how participants identified and selected problem areas and recognized how addressing these challenges was important and the value their solutions could provide. The motivation stemmed from lived experiences such as professional exposure, personal experiences, observations, or evidence-based knowledge through research and factual data. Opportunity, in this case, is primarily centered around the benefits their solutions offer to their user groups.

Sub Themes: (1) Problem Identification grounded in lived experience, (2) Problem Identification through evidence-based knowledge, and (3) Benefits.

Theme 2: Design and Application

This theme captures how participants developed, refined, implemented, and communicated their solutions throughout the design process. It reflects participant engagement with technical and practical aspects of building the prototype, including running into roadblocks with their designs, navigating these challenges and overcoming them, and making informed decisions through iteration and reflection. Participants explained how the design’s functionality was technically implemented using various technologies (e.g., software packages, programs, coding) and demonstrated these functionalities through demos and walkthroughs. Through their video presentations, the participants showcased their ability to communicate their designed solutions in a clear, simple, and concise manner, which was easy to understand for non-technical audiences as well.

Sub-themes: (1) Design Considerations, (2) Challenges, (3) Navigating Challenges, (4) Communicating Design, (5) Design and Technical Execution, and (6) Demonstrating Design Functionality.

Theme 3: Impact and Growth

This theme highlights how participants reflected on their learning, personal growth, next steps for their designs, and implications of their created solutions. Participants acknowledged gaining technical, collaborative, and problem-solving skills and showed increased confidence and perseverance despite challenges during the design process. Participants also discussed what they would do with their prototypes moving forward (e.g., refining existing design, adding new functions, making their designs scalable). Furthermore, participants stated that they incorporated consumer feedback to make improvements to their designs.

Sub-Themes: (1) Learning from the design process, (2) Future Directions, (3) Improved Self-efficacy, and (4) Continuous Improvement.

The table below (Table 3) highlights new themes that emerged from the current round of analysis and compares them with those from previous events. ‘Yes’ indicates that the themes were observed in previous data sets, and ‘No’ indicates that the themes were not observed.

Table 3. Comparison of Themes found in Qualitative Analysis

Event	**Theme 1: Motivation and Opportunity**			**Theme 2: Design and Application**						**Theme 3: Impact and Growth**			
Sub-themes	**(1)**	**(2)**	**(3)**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(1)**	**(2)**	**(3)**	**(4)**
Hackathon 2022	No	No	Yes	Yes	No	No	No	Yes	Yes	No	Yes	No	No
Makeathon 2022	No	No	Yes	Yes	No	No	No	Yes	Yes	Yes	No	No	No
Hackathon 2023	No	No	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	No	No
Makeathon 2023	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes	No	No	No

Hackathon 2024	No	No	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes	No	No
Makeathon 2025	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Hackathon 2025	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Discussion

The descriptive statistics findings provide a preliminary profile of how students and judges interpret EM performance within hackathon and makeathon contexts. Consistent with prior phases of this work, students rated themselves more favorably than judges across all rubric dimensions. The agreement between judges' and students' ratings was strongest in innovation, communication, breadth, and complexity, and weakest in curiosity, impact, and navigating challenges. Differences are observed between independent and challenge-related projects, as well as when removing cases where students uniformly rate themselves as "accomplished." Variations between Hackathon and Makeathon events further point to contextual factors potentially shaping students' perceived performance.

Themes and subthemes were extracted from the transcribed data, and a preliminary qualitative data analysis was conducted as demonstrated above. Based on the thematic analysis results for the Makeathon and Hackathon 2025 data and comparing these results with previous analysis, a few notable differences were observed. Specifically, notable differences emerged in four primary areas: how participants identified their problem topics, the ways they presented their final designs, their articulation of the design process, and the perceived impact on their personal and professional goals. Building upon current and previous thematic analyses, our findings demonstrate strong alignment with the EM rubric dimensions, with participant responses represented across all primary thematic areas. Overall, the findings indicate that the intervention effectively elicits EM components fundamentally shaping how participants engage with and articulate their design solutions.

Conclusion and Future Work

This paper presents a WIP study examining how EM is elicited and assessed through hackathon and makeathon events. Building on prior publication [1] that detailed initial implementation of an EM-based intervention, this WIP paper reports on three completed rounds of data collection across the Hackathon 2024, Makeathon 2025, and Hackathon 2025 events. The study employed a mixed-method design, integrating quantitative rubric-based scoring with qualitative thematic analysis of student video presentations. Quantitatively, descriptive statistics revealed a consistent pattern in which students rate themselves more favorably than judges across all rubric dimensions. The smallest gaps were observed in innovation, communication, breadth, and complexity. Whereas there were larger gaps in curiosity, impact, and navigating challenges. Qualitatively, thematic analysis identified three overarching themes: motivation and opportunity, design and application, and impact and growth, with new sub-themes emerging in the most recent events that reflect deeper student engagement with EM constructs.

Future work will report on ongoing analysis to assess the rubric's reliability and potential improvements in its construction and administration. Currently, the project has completed three rounds of data collection and implemented changes intended to improve the quality of engagement with the rubric. The significance of the quantitative trends observed will be more formally investigated, including consideration of inter-rater reliability analysis to assess rubric consistency and shared interpretation among judges and students. Additionally, further data collection took place during the Spring 2026 semester for the Makeathon 2026 event, completing the data set and allowing for a more comprehensive assessment to be presented in a future publication.

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