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Introducing the Entrepreneurial Mindset into Classes at NC State University

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Abstract

Introducing a new initiative at a large campus like NC State University is challenging; key hurdles include showing how the initiative builds on existing efforts without replacing them, introducing faculty to the new ideas, creating buy-in, and providing an incentive for engagement. As a new member of the Kern Entrepreneurial Engineering Network (KEEN), our goal was to introduce the Entrepreneurial Mindset (EM) to faculty across the College of Engineering, provide guidance on how to apply those ideas in classroom content, and encourage rapid adoption of EM across the curriculum. Our approach includes several training opportunities, continuous engagement, and microcredentials to achieve these goals. The NC State Wolfpack Engineering Unleashed Incubator was designed as a two-day, in-person workshop for small groups of faculty to learn about the main EM concepts: curiosity, connections, and creating value. To these "3 Cs", we added collaboration, communication, and character as the spine of our marketing strategy on campus, called Wolfpack Engineering Unleashed (WEU). Each faculty member participating in the Incubator was coached to create a module for their classes over the following year. In addition, we incorporated a subset of these materials in the new faculty orientation for the College of Engineering and have developed other on-campus interactions (*e.g.,* Book Club) to have continuous engagement with faculty outside the intensive workshop. Most recently, we have developed a microcredential program to promote, value and recognize faculty engagement with EM at different levels. This paper will describe these efforts (incubator, continuous engagement, microcredentials) and present the reach of the program as well as the impact on faculty understanding and confidence in applying EM concepts.

Introduction

Entrepreneurial mindset (EM) is defined as a set of attitudes and habits that shape problem-solving, innovation, and value creation by amplifying technical engineering skills. Individuals trained to apply EM to their problems solving are intended to be more proficient at recognizing opportunities, drawing connections, and creating value (EngineeringUnleashed.com) [1]. The Kern Entrepreneurial Engineering Network (KEEN) is a partnership of >60 colleges and universities that seeks to infuse EM into engineering education to create best practices and train faculty. In 2020, our NC State faculty were disengaged from the national efforts to embed EM into classroom instruction. The authors were among the first faculty (teaching and tenure-track faculty) at NC State to attempt to start the movement on campus to teach with more EM.

The authors worked within the system at NC State to build a coalition to become a KEEN partner school. NC State has had an excellent relationship with industry for more than 25 years, but the efforts at entrepreneurial thinking were aimed primarily at students or at faculty who wanted to turn their research into a business. Classroom education in the College of Engineering typically did not include conversation of stakeholders, value tensions, value creation, or connections across the curriculum. Additionally, a drop in students' engagement was reported by faculty and instructors in the College of Engineering, exacerbated by the COVID19 pandemic.

The goal of this work was to develop a set of training and activities at NC State to rapidly raise understanding of EM among faculty, increase confidence in applying the concepts of EM in course design, and reach faculty and students across the college. This paper will describe these efforts (specifically, intensive training incubator, continuous engagement, microcredentials) and present the reach of the program as well as the impact on faculty understanding and confidence in applying EM concepts.

Methods

We developed our effort under an umbrella program we call the NC State Wolfpack Engineering Unleashed (WEU) network. WEU encompasses our activities as well as branding the focus on 1) the fundamental principles of EM called the 3 Cs: curiosity, connections, and creating value and 2) 3 additional principles: collaboration, communication, and character. All of our activities under WEU emphasize the "6 Cs" and their incorporation into the curriculum, and promote using a consistent terminology. We acknowledged to faculty that many may be incorporating some of these concepts into their teaching already, but a common vocabulary will help make these efforts more transparent to students and consistent throughout the curriculum. We developed a **one-page guide to EM**, which we handed out at faculty meetings and emailed to department heads and college leaders (see **Appendix A**).

We then developed a series of activities and workshops to offer a diversity of opportunities for faculty training, networking and community building, as follows:

- Presentations at faculty meetings
- Incubator (a 2-day workshop for faculty with 1 year of coaching afterwards)
- Continuous Engagement (*e.g.,* book clubs and Lunch and Learns)
- Certificate Program

Presentations at Faculty Meetings

Overview: Presentations at faculty meetings were used to introduce the College of Engineering departments to the WEU initiative, provide context for EM, and invite faculty to engage in the WEU activities. These faculty presentations averaged about 10 minutes in length. The overall approach was to 1) inquire about primary concerns faculty had about teaching and 2) deliver brief evidence that EM can address common concerns.

Detailed approach: Howard began the introductions at faculty meetings by passing out index cards or post-it notes: what is your biggest concern about teaching? In each department (6 presentations as of January 2025), the prevailing answers were typically related to 1) student engagement and 2) limited time to transform teaching. The reality that students are less motivated by "normal" lectures has been shown many times [2]. The faculty frustration in student engagement was used in our presentations as a springboard to introduce curiosity: as students become more curious about the topic, they are necessarily more engaged. The presentations briefly touched on the sweet-spot between anxiety and apathy and dispositional *vs.* epistemic curiosity [3].

To address concerns around limited preparation time, we delivered a concrete example of how to simply transform an existing homework assignment [4]. Our working hypothesis was that faculty

were basically interested but had little time to change, and providing concrete evidence that change can be introduced quickly supported the goal of bringing faculty on board.

Our presentations included an explicit request: faculty should work to help students build connections between the content of their lectures and the real world and the connections between their lectures and other classes. Our contention was that while faculty often had these connections in mind, they needed encouragement to add them explicitly to their lectures and homework. Another typical reaction from faculty is the study skills of students, specifically the students' belief that engineering can be learned by cramming before the exams [5]. We contend that students facing an open-ended project with real-world implications start to understand that they need to work a bit at a time; offering such projects with multiple deadlines can help students.

Incubator

Overview: An intensive on campus workshop (called the WEU Incubator) was delivered to provide in-depth education to faculty on the 6 Cs of EM with year-long coaching to implement EM in courses. As a KEEN partner school, we had five golden tickets (*i.e.,* all travel expenses covered) to award for faculty to travel to Engineering Unleashed Faculty Development opportunities, but NC State is large with almost 500 full-time faculty in the College of Engineering. With natural turnover, five trained faculty each year would not spread these concepts much at all. Our workshop was inspired by the hugely-successful Integrating the Curriculum workshop from KEEN's Engineering Unleashed Faculty Development [6].

Detailed approach: The Incubator was a two-day workshop. Before the workshop, faculty were asked to complete pre-work that included identifying the course that they would be working on improving during the incubator. The basic schedule for our days is shown in **Table 1**. The Incubator itself was designed as a model class, using active learning EM activities to expose the faculty to EM concepts, while also demonstrating how example activities can be delivered in a classroom setting.

Table 1. *Two-Day Agenda for Incubator*

	TIME	**ACTIVITY**
Day 01	1. 8:30 - 9:10 am	1. Breakfast and Welcome
	2. 9:10 - 9:45 am	2. The 35 Activity
	3. 9:45 - 10:05 am	3. What are the 6 C's and why do they matter?
	4. 10:05 - 10:30 am	4. Break: Reflection on what course are you choosing to focus on and what problems are you seeking to solve?
	5. 10:30 - 11:30 am	5. Hooks and Problem-Based Learning
	6. 11:30 - 12:30 pm	6. Creating Value, Design Activity
	7. 12:30 - 1:30 pm	7. Lunch
	8. 1:30 - 2:30 pm	8. Curiosity, Think-Pair-Share Activity
	9. 2:30 - 3:00 pm	9. Question Formation Technique
	10. 3:00 - 3:15 pm	10. Break
	11. 3:15 - 3:45 pm	11. Connections
	12. 3:45 - 4:25 pm	12. Jigsaw Activity, The Other 3 C's
	13. 4:25 - 4:30 pm	13. Wrap Up

	14. 4:30 - 5:30 pm 15. 5:30 - 7:00 pm	14. Break 15. Social Dinner
Day 02	1. 8:30 - 9:00 am 2. 9:00 - 9:10 am 3. 9:10 - 9:40 am 4. 9:40 - 10:15 am 5. 10:15 - 10:35 am 6. 10:35 - 11:15 am 7. 11:15 - 12:05 pm 8. 12:05 - 12:45 pm 9. 12:45 - 1:00 pm 10. 1:00 - 2:30 pm 11. 2:30 - 4:30 pm 12. 4:30 - 4:40 pm 13. 4:40 - 4:50 pm	1. Breakfast 2. Welcome, Day 1 Recap 3. Reflection Activity 4. Concerns Group Conversation 5. Coffee Break and Gallery Walk 6. Jigsaw Activity Conclusion 7. Assessment: Grading and Rubrics 8. Lunch, Pool Noodle Activity 9. Campus Resources 10. Develop Your Own Project 11. Presentations of Participant Projects 12. Cohort Formation 13. Closing, Next Steps

Individual coaching was offered to all faculty at the end of the incubator. Over the next academic year, coaches reached out to faculty to meet four times to help with forming the activities, assessing them, and publishing Cards (*i.e.,* online documentation of course activities published on the EngineeringUnleashed.com website). These conversations happened individually for the first and third meetings and in a group of faculty for the second and fourth meetings to encourage faculty to feel like they were part of a team. Our second Incubator included several faculty who lead the Engineering First Year program for incoming freshman students, which reaches almost every student in the College of Engineering (>700 first-year engineering students).

The incubator welcomes participants with diverse teaching experience levels and course demands, including participants with less than 5 years to over 20 years of teaching experience and participants lecturing to class size from 15 to up to 300 students. The majority of the surveyed participants offer courses at the undergraduate level often to large classrooms of students.

Continuous Engagement: Lunches and Book Clubs

Overview: After the first Incubator, faculty reported enjoying working together to improve their classes. They regretted that there was so little time to come together. Our team pivoted to providing Lunch and Learns and Book Clubs for continuous engagement.

Detailed approach: Lunch-and-Learns are offered six times per year and draw between 10 and 15 faculty each session from a rotating set of attendees. Sample topics include “Make the most of KNC”, “Grading Easier with Gradescope”, “How to Publish a Card on EngineeringUnleashed.com”.

Each summer, the team provides a Zoom-based book club with books chosen from KEEN National Conference recommendations. The book club welcomes on average six faculty each summer.

Microcredentials

Overview: WEU microcredentials are used to encourage faculty participation and recognize faculty achievement and engagement in EM. We have developed a 5-level microcredential program (**Figure 1**) that recognizes faculty achievement at their different learning and engagement stages in EM [7]. This program was launched in Fall 2024. Credly is used to deliver the credential for public display and recipients also receive an enamel lapel pin. Recipients are celebrated and recognized at an annual social event for WEU participants and supporters.

Figure 1. *Five levels of certification for NC State faculty and staff*

Each credential has learning objectives and a form submission to apply for the rank. Thirty awards have been given in the first two months of this program. The certificate program has given us a way of tracking faculty completion past the coaching: for example, achieving level 3 requires the publication of a paper or a card on Engineering Unleashed.

Assessment

To evaluate the reach of the WEU activities on faculty and students, we recorded the number of faculty engaged in training, impacted student credit hours, number of microcredentials issued, and number of Engineering Unleashed cards published.

Pre- and post-incubator surveys were developed to assess the success of the incubator in increasing faculty participants' confidence and skills in incorporating EM (specifically, each of the 6 Cs) into their course design and curriculum. Differences in the pre- and post-surveys were analyzed using a 2-way repeated measures ANOVA (factors: survey timepoint, item category).

Results

WEU Incubator

Since its first offering in 2023, the two-day incubator has been offered to 25 faculty, lecturers and advisors at NC State University (**Table 2**). We noticed a growing interest in participation in this workshop with a higher number of participants in 2024 than in 2023, and a higher response rate to the post-incubator survey (86% in 2024 *vs.* 18% in 2023).

Table 2. *Faculty Reached by our Annual Incubator*

	2023	2024
Total number of participants	11	14
Tenure track	5	7

Professional track	4	3
Administrative	2	4

Pre- and post-incubator surveys were distributed to the workshop participants to evaluate their level of confidence in integrating and implementing activities that demonstrate the six concepts of curiosity, connections, creating value, communication, collaboration, and character (the 6 Cs) within the framework of EM. The detailed list of survey questions is available in **Appendix B**.

Overall, the incubator fostered participants' confidence in implementing all the 6 Cs into the classroom (**Figure 2**). Post-incubator responses showed an increase in the percentage of individuals who were confident in applying the 6 Cs (somewhat, moderately, or extremely confident) of 41% over the pre-incubator responses ($p<0.001$). There was a significant effect of item category (curiosity, connections, creating value, other 3 Cs) on responses as well ($p=0.002$), with the highest change for "connections" (51%) and the lowest for "the other 3 Cs" (34%). The baseline confidence for curiosity was the highest (62% confident) and connections was the lowest (36%).

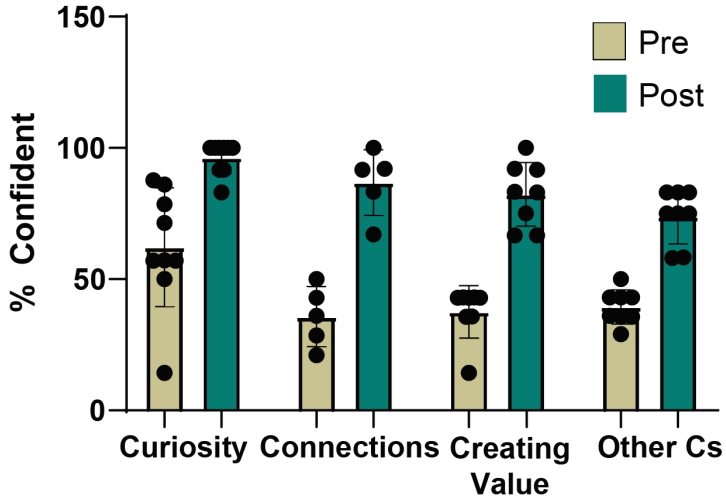

Figure 2. Pre- (before) and post- (after) incubator survey responses by item category. Each data point indicates the percentage of respondents indicating confidence to a specific question.

Responses to individual items varied within categories in the post-incubator responses in a way that reflected the design of activities included in the incubator (**Figures 3-6**). For example in curiosity, some participants still expressed low confidence with implementing activities requiring "challenging assumptions" and "examining data that supports unpopular solutions", whereas high confidence was expressed for "generating their own questions". These response rates align with the type of activities included in the incubator. For instance, we engaged the participants in a Question Formulation Technique (QFT) activity to illustrate how to raise students' curiosity on a specific topic [6]. We did not, however, explicitly illustrate activities "challenging assumptions" or "examining data that supports unpopular solutions".

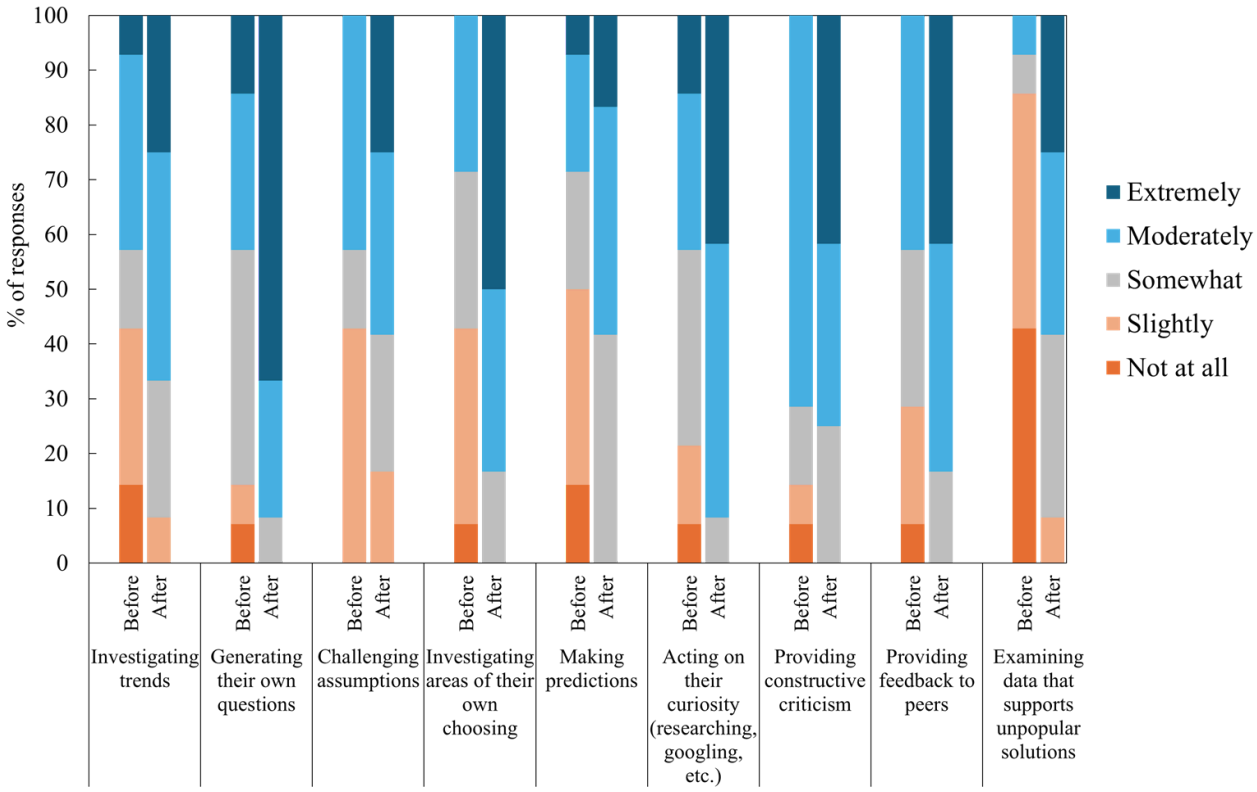

Figure 3. Pre- (before) and post- (after) incubator survey responses to the question: *"How confident are you in implementing activities that demonstrate student **curiosity** by [x-axis label]"*.

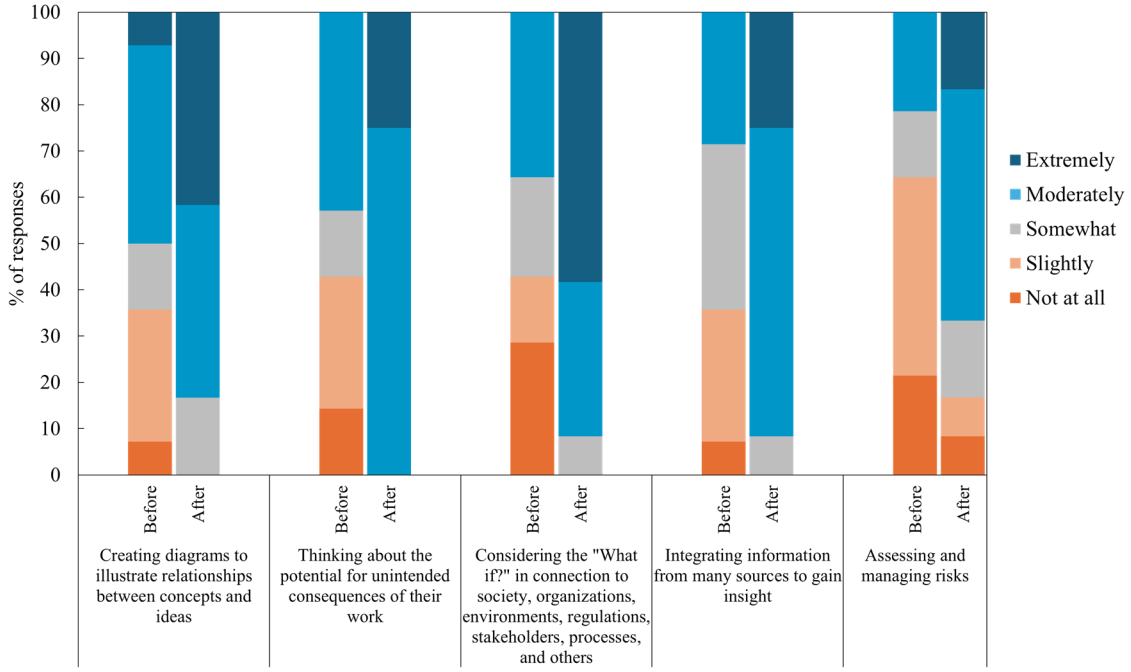

Figure 4. Pre- (before) and post- (after) incubator survey responses to the question: *"How confident are you in implementing activities that demonstrate student **connections** by [x-axis label]".*

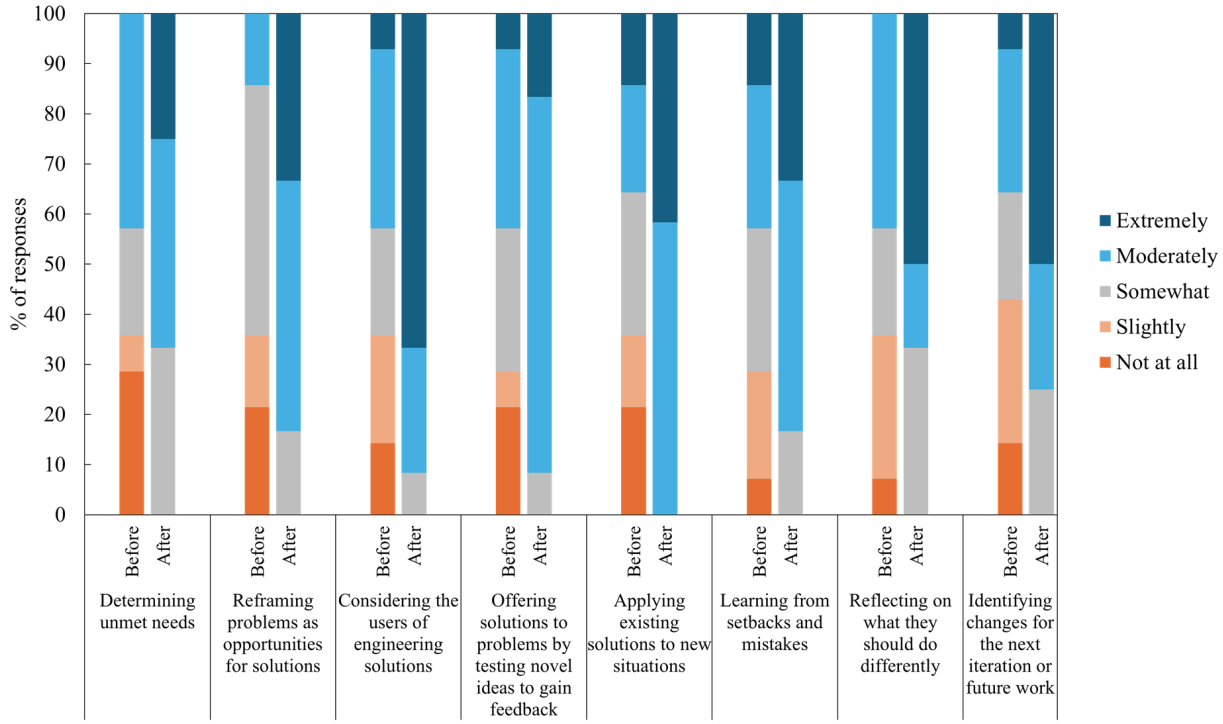

Figure 5. Pre- (before) and post- (after) incubator survey responses to the question: *"How confident are you in implementing activities that **create value** by [x-axis label]".*

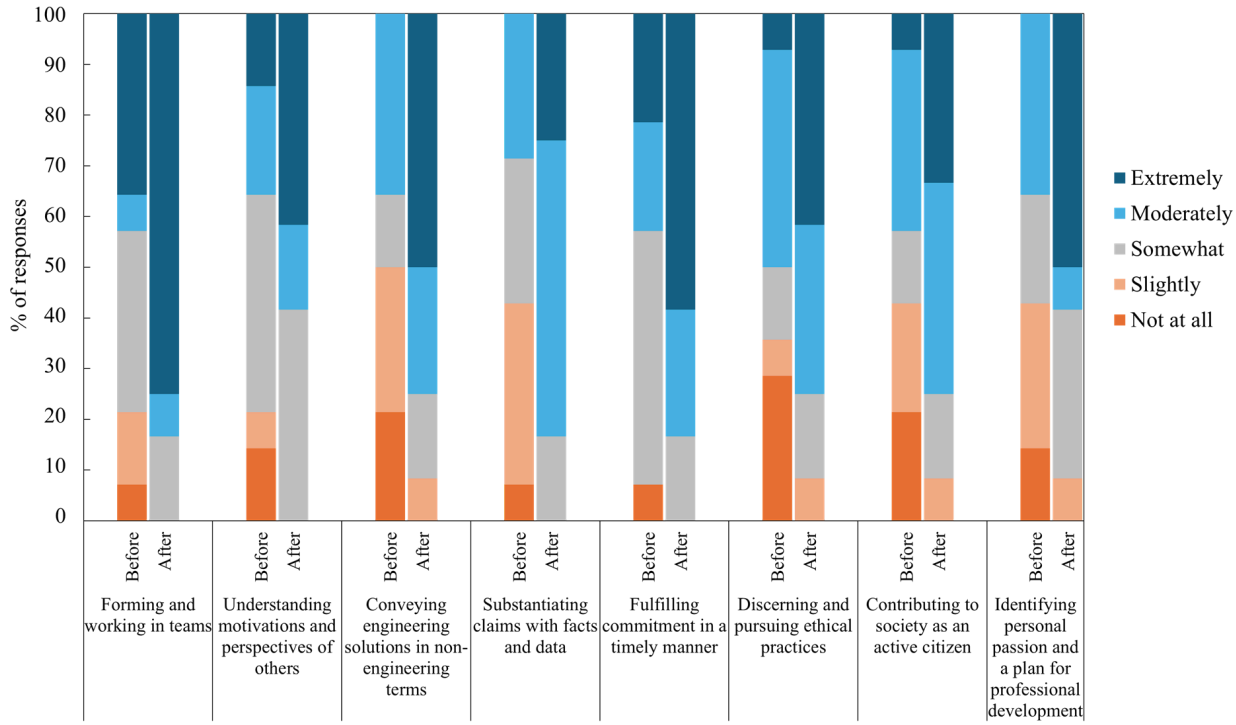

Figure 6. Pre- (before) and post- (after) incubator survey responses to the question: *"How confident are you in implementing activities that develop **communication, collaboration and character** of your students by [x-axis label]".*

As a result of the initiatives described in this paper, the number of NC State faculty who have joined EngineeringUnleashed.com has increased from 3 to more than 60 within two years. The number of cards published by NC State's faculty has reached 29 published cards as of January 2025. Among our WEU faculty, 3 were nationally recognized by KEEN for their EM-related activities and engagement on campus and beyond. These awards include Engineering Unleashed Fellows and KEEN Rising Stars.

Conclusion and Future Work

Our program has included faculty meeting presentations, presentations at New Faculty Orientation in the College of Engineering, a two-day workshop with a year-long coaching program, Lunch-and-Learn programming, Book Clubs, and Microcredentials. We have hosted Crescendo events from KEEN and individual speakers from the network. With these efforts, we have grown WEU from nothing into a network across all eleven departments in the College of Engineering, with 89 members on our email listserv. Our faculty involvement has grown substantially each year. We look forward to seeing the growth continue throughout the college with the ultimate goal that no student can graduate without encountering EM in, at least, three courses.

Future work will involve expanding our learning and offering to graduate students, future-to-be faculty members and lecturers, and connecting to other Colleges across campus, among other initiatives.

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Appendix A

What is the Entrepreneurial Mindset (EM)?

- A successful entrepreneur is curious about the world. They connect ideas and solutions to create value.
- The same traits that make a successful entrepreneur make a great engineer, a great teacher, a great novelist, a great surgeon, and even a great factory employee. More and more 21st-century jobs will ask the employee to be creative, to notice and capitalize on connections between unexpected things, and to keep in mind the stakeholders and their needs.
- Higher education needs to pivot away from purely-lecture-based techniques to offer experiences where students can develop this mindset.
- Teaching using active and problem-based learning helps more of our students learn and retain course content. We can build on these techniques to explicitly challenge our students to maintain or develop their curiosity, look for connections between their lived experience and the course content, and go on to create value in the world.
- Read through the Framework for more information.

Possible benefits:

- Students who are engaged in their education are better motivated. Students who are on a hunt for knowledge to solve problems know the answer to “Why does this even matter?”
- The mental health of our university students has never been more challenged. Teaching the Entrepreneurial Mindset (EM) may help students combat depression and anxiety by giving them purpose and direction.

- Researchers have reported that students trained in EM make better grad students and undergraduate researchers.

- Teachers watching their students come alive as they search for pressing problems find the experience more invigorating than giving the same lecture again. Instructors who are provided training and/or support can make small changes to how they teach core concepts to add an EM perspective to their course, resulting in big impact. The grand challenges of our world need grand solutions. We should challenge our students to find them, equip them with the tools they need to do so, and allow them to lead us to a better world.

FAQ:

- How do I fit even more stuff into my class? It's already full.
    - Teaching with EM isn't extra content. It's a way to present the same content. It's the "why" behind the "what" you're describing. For example, choosing an example with a real-world connection or a world challenge doesn't take any longer than choosing an example out of the textbook -- at least not once you've worked through that example once.

- How is entrepreneurially minded learning (EML) different from teaching entrepreneurship?
    - We're not talking about teaching how to start a business, though such topics can certainly be a subset of EM. EML is much broader: we aim to get every student to exercise their curiosity, to look for connections between their classes and real world situations, and to look for ways to create value in the world.

Check out engineeringunleashed.com to find examples of EM in the classroom.

Appendix B

For each of the following questions a Likert-scale was used: Not at all, Slightly, Somewhat, Moderately, Extremely.

1. How confident are you in implementing activities that demonstrate student **curiosity** by: [Investigating trends]

2. How confident are you in implementing activities that demonstrate student curiosity by: [Generating their own questions]

3. How confident are you in implementing activities that demonstrate student curiosity by: [Challenging assumptions]

4. How confident are you in implementing activities that demonstrate student curiosity by: [Investigating areas of their own choosing]

5. How confident are you in implementing activities that demonstrate student curiosity by: [Making predictions]

6. How confident are you in implementing activities that demonstrate student curiosity by: [Acting on their curiosity (researching, googling, etc.)]

7. How confident are you in implementing activities that demonstrate student curiosity by: [Providing constructive criticism]

8. How confident are you in implementing activities that demonstrate student curiosity by: [Providing feedback to peers]

9. How confident are you in implementing activities that demonstrate student curiosity by: [Examining data that supports unpopular solutions]

10. How confident are you in implementing activities that build **connections** by: [Creating diagrams to illustrate relationships between concepts and ideas]

11. How confident are you in implementing activities that build connections by: [Thinking about the potential for unintended consequences of their work]

12. How confident are you in implementing activities that build connections by: [Considering the "What if?" in connection to society, organizations, environments, regulations, stakeholders, processes, and others.]

13. How confident are you in implementing activities that build connections by: [Integrating information from many sources to gain insight]

14. How confident are you in implementing activities that build connections by: [Assessing and managing risks]

15. How confident are you in implementing activities that **create value** by: [Determining unmet needs]

16. How confident are you in implementing activities that create value by: [Reframing problems as opportunities for solutions]

17. How confident are you in implementing activities that create value by: [Considering the users of engineering solutions]

18. How confident are you in implementing activities that create value by: [Offering solutions to problems by testing novel ideas to gain feedback]

19. How confident are you in implementing activities that create value by: [Applying existing solutions to new situations]

20. How confident are you in implementing activities that create value by: [Learning from setbacks and mistakes]

21. How confident are you in implementing activities that create value by: [Reflecting on what they should do differently]

22. How confident are you in implementing activities that create value by: [Identifying changes for the next iteration or future work]

23. How confident are you in implementing activities that develop **collaboration, communication and character** of your students by: [Forming and working in teams] **(Focus is Collaboration)**

24. How confident are you in implementing activities that develop collaboration, communication and character of your students by: [Understanding motivations and perspectives of others] **(Focus is Collaboration)**

25. How confident are you in implementing activities that develop collaboration, communication and character of your students by: [Conveying engineering solutions in non-engineering terms] **(Focus is Communication)**

26. How confident are you in implementing activities that develop collaboration, communication and character of your students by: [Substantiating claims with facts and data] **(Focus is Communication)**

27. How confident are you in implementing activities that develop collaboration, communication and character of your students by: [Fulfilling commitment in a timely manner] **(Focus is Character)**

28. How confident are you in implementing activities that develop collaboration, communication and character of your students by: [Discerning and pursuing ethical practices] **(Focus is Character)**

29. How confident are you in implementing activities that develop collaboration, communication and character of your students by: [Contributing to society as an active citizen] **(Focus is Character)**

30. How confident are you in implementing activities that develop collaboration, communication and character of your students by: [Identifying personal passion and a plan for professional development] **(Focus is Character)**