

# Special Session: Calling All Voices: Transforming Scholarly Perception of an Entrepreneurial Mindset Framework through a Community-Led Delphi Study

Cheryl Bodnar  
Rowan University  
Glassboro, New Jersey, USA  
bodnar@rowan.edu

Prateek Shekhar  
New Jersey Institute of Technology  
Newark, New Jersey, USA  
prateek.shekhar@njit.edu

Samantha Brunhaver  
Arizona State University  
Mesa, Arizona, USA  
samantha.brunhaver@asu.edu

Alexandra Jackson  
Rowan University  
Glassboro, New Jersey, USA  
jacksona4@rowan.edu

Brendan Rucci  
Rowan University  
Glassboro, New Jersey, USA  
ruccib0@rowan.edu

Adam Carberry  
The Ohio State University  
Columbus, Ohio, USA  
carberry.22@osu.edu

Sanjeev Kavale  
Arizona State University  
Mesa, Arizona, USA  
sanjeev.kavale@asu.edu

**Abstract**—The 3Cs framework, emphasizing curiosity, connections, and creating value, was developed by the Kern Entrepreneurial Engineering Network (KEEN) to integrate an entrepreneurial mindset into engineering education. The framework has gained acceptance among practitioners, but the lack of explicit ties to existing theoretical literature has hindered its use in entrepreneurial mindset and engineering education research. This special session is part of a larger Kern Family Foundation-funded project to develop and disseminate a literature-based grounding for the 3Cs framework that can provide a foundation for research using the framework through existing scholarly literature. Building on scoping reviews of the literature, the session adapts the Delphi method to collaboratively operationalize each part of the 3Cs framework with members of the entrepreneurship and engineering education communities. Participants will rate their agreement with high-level constructs associated with each C, as identified from the literature, and engage in peer-to-peer discussions to reach a collective understanding of the operationalization of each C. Expected outcomes for participants include a deeper understanding of how the 3Cs framework aligns with broader theoretical perspectives in existing literature, as well as insights for leveraging the 3Cs in entrepreneurial mindset-related program development, research, and assessment. In addition, the facilitation team will use the information gathered during this and four other similar sessions to develop its literature-based foundation for the 3Cs framework, produce a set of highly citable references to support work using the 3Cs, and disseminate project findings through KEEN resources, archival publications, and public media.

**Keywords**—*entrepreneurial mindset, curiosity, connections, creating value, modified Delphi method.*

## I. GOALS AND MOTIVATION

Entrepreneurial mindset is increasingly recognized as a critical developable attribute in engineering higher education [1]. One widely adopted conceptualization of entrepreneurial

mindset has been the Kern Entrepreneurial Engineering Network (KEEN) 3Cs conceptual framework, which identifies three key attributes: curiosity, connections, and creating value [2]. This framework has informed curriculum development, faculty training, and student development initiatives at KEEN partner schools and beyond, e.g., [3]-[5]. KEEN has grown to include more than fifty partner institutions, and its website, Engineering Unleashed [6], has influenced many universities within and outside the network. This impact is evident through publication searches in the American Society of Engineering Education (ASEE) PEER repository (420 publications on entrepreneurial mindset and KEEN's 3Cs in the past 20 years) and Google Scholar (87 publications using the framework).

The flexibility of the 3Cs framework enhances its adaptability among practitioners, but its widespread use has also contributed to nuanced and varied operationalizations of the 3Cs. These operationalizations, combined with the framework's lack of direct association with existing theoretical literature, limits the suitability of the framework in scholarly research and associated publishing in high-impact academic journals. This special session will present work tied to a larger project focused on transforming the scholarly perception of the KEEN 3Cs framework through the development of a literature and community-based foundation for the framework. A modified Delphi method approach will be used during the session to actively engage participants to operationalize curiosity, connections, and creating value, with an emphasis on building a shared operationalization of the 3Cs that is grounded in existing literature and practitioner feedback.

## II. DESCRIPTION AND RELEVANT LITERATURE

This session is part of a larger project funded by the Kern Family Foundation to develop and disseminate a literature and community-based foundation for the 3Cs framework to a wide range of audiences. The project builds on London et al. [7],

who established a framework centered on the 3Cs using a bracketing process. A “state of the art review” expanded the initial framework by incorporating thoughts and definitions from the literature that were initially overlooked in the framework until saturation was reached. The result was a framework mapping the 3Cs to twelve mindset outcomes and sixteen behavioral outcomes [7]. This framework then informed the creation of a quantitative survey instrument to measure entrepreneurial mindset among undergraduate engineering students [8].

The current project extends this prior work so that future efforts framed by the 3Cs receive greater acceptance from a more diverse range of peer-reviewed academic journals, particularly high-impact journals. Such acceptance would not only highlight the outcomes associated with the valuable work of practitioners using the KEEN framework but also facilitate the broader dissemination of entrepreneurial mindset research to institutions and programs outside of KEEN. The project contains two sequential phases. Phase 1 involved scoping reviews of relevant literature for each of the 3Cs, while Phase 2 leverages a series of modified Delphi studies with the entrepreneurship and engineering education communities. Together, these phases provide the necessary data and insights to unpack an underlying literature and community-based structure to support the KEEN 3Cs framework. The progress to date for each phase is summarized below.

#### *Phase 1: Scoping Literature Reviews*

We conducted a series of scoping literature reviews to deepen our understanding of current research related to curiosity, creating value, and connections. Scoping literature reviews are commonly used to explore and synthesize existing studies on a particular topic, offering an overview of current knowledge, trends, relationships, and patterns [9]. Our specific goal with the scoping reviews was to substantiate the 3Cs framework by identifying specific sub-constructs associated with each C in literature.

Our scoping literature review process involved three steps. First, we augmented the traditional approach to performing scoping literature reviews by conducting a content analysis of the KEEN Engineering Unleashed website, as well as interviews with seven KEEN leaders who provided feedback on the 3Cs’ initial development [10]. This approach helped us understand the original conceptualization of the 3Cs. Second, we used insights from these analyses to develop search terms for literature reviews on each C of the framework: curiosity, connections, and creating value (e.g., “asking questions,” “brainstorming,” “showing interest,” and “uncovering information” for curiosity). Finally, we performed three separate scoping literature reviews (one for each C) following the guidelines for scoping reviews laid out by Petticrew and Roberts [9]. The process included using the search terms mentioned above to identify candidate papers, screening the papers based on a set of inclusion and exclusion criteria, critically evaluating and extracting the key contents of each paper, and summarizing the findings. Papers were identified using three online library databases: Engineering Village, ProQuest, and Scopus. Our inclusion criteria focused on peer-reviewed journal articles and conference proceedings published

in English since 1980, when research related to entrepreneurship education began to proliferate. Abstracts for these papers were screened using the Rayyan.ai software tool [11], applying criteria that excluded any publication focused on K-12 education, a field unrelated to our target area of engineering education, or topics not pertinent to curiosity, connections, or creating value. Publications referencing KEEN or the 3Cs were also excluded.

After filtering out nonrelevant articles, we were left with 53 papers related to curiosity, 31 papers related to connections, and 146 papers related to creating value. For each set of papers, we summarized the findings in terms of definitions, frameworks, theories, and measurements used to operationalize the respective C in the existing literature. These summaries were then compiled into reports, which served as the basis for our modified Delphi studies with members of the entrepreneurship and engineering education communities. A journal manuscript detailing the findings of the scoping reviews is currently in preparation.

#### *Phase 2: Modified Delphi Studies*

Building on our scoping reviews, we have been engaging members of the entrepreneurship and engineering education communities in a series of modified Delphi studies to collaboratively operationalize each C in the 3Cs framework. The Delphi method is a well-established technique for identifying consensus on a topic across diverse expert opinions, comments, and feedback [12]. Specifics of the Delphi method can vary, resulting in modified versions, but the general approach remains the same: (1) it has multiple rounds where a group of experts are asked their opinion on a particular issue, (2) rounds build on each other such that participants see the results of the previous round before the start of the next round, allowing them to reflect and reconsider their opinions based on the opinions of other participants, and (3) the final results from each round are shared anonymously to prevent bias from participant concerns that their opinions will be viewed negatively by other participants [12]. In our case, the Delphi method also ensures mitigation of research bias and trustworthiness by presenting participants with literature-based findings and asking them if these interpretations resonate with their perceptions of the 3Cs, leading to confirmation and modification of construct mapping [13]. In this way, not only can a consensus among experts emerge, but both the participants and researchers can learn from each other.

We describe our process as a modified Delphi study, as it differs from the traditional Delphi study in several key ways: (1) participants meet face-to-face, (2) the study occurs within a single meeting, (3) all participants are affiliated in some way with the same professional association, potentially with prior familiarity with one another, and (4) this shared membership may lead to a slightly less heterogeneous participant population than typically recommended [13].

Within these parameters, each Delphi study addresses one of the 3Cs at a time and includes two to three rounds of consensus-building for each C. In the first round, participants review and discuss high-level constructs associated with the C under examination based on our scoping review findings, rank the importance of these constructs individually, and discuss the

aggregate rankings as a large group. In the second round, participants brainstorm keywords and themes associated with the current C, submit these for consideration individually, and reflect on the resultant word cloud as a large group. When time permits, a third round is held allowing participants to collaboratively develop definitions for the current C, rate their agreement with each definition individually, and discuss aggregate ratings as a large group. Importantly, each round includes three components: an initial small-group segment for peer-to-peer interaction and collective understanding, a solitary segment for individual reflection, and a large-group segment for sharing reactions to the results.

To date, we have piloted the modified Delphi method in special sessions at four different 2024 conferences: KEEN National Conference in Austin, Texas; ASEE Conference for Industry and Education Collaboration (CIEC) in Garden Grove, California; VentureWell OPEN Conference in San Diego, California; and ASEE Annual Conference in Portland, Oregon. Participants have included undergraduate students, graduate students, postdoctoral scholars, faculty, administrators, and industry professionals. They typically have come from engineering, engineering education, entrepreneurship, and business backgrounds and have brought varying levels of understanding and expertise with KEEN, the 3Cs, and entrepreneurial mindset.

Early special sessions were only able to focus on a subset of the 3C's, while later sessions have covered multiple Cs. The special session being conducted at the 2024 IEEE/ASEE Frontiers in Education Conference in Washington, D.C., will include modified Delphi studies for all 3Cs: curiosity, connections, and creating value.

### III. RATIONALE AND NOVELTY

This special session actively engages in the collaborative operationalization of the 3Cs using a modified Delphi method, thus contributing to a literature and community-based grounding of the framework. This goal aligns with the overarching theme of the 2024 IEEE/ASEE Frontiers in Education Conference [14] because entrepreneurial mindset is imperative in embracing the challenges and transforming engineering and computing education in our technology-enhanced world. A literature and community-based grounding for entrepreneurial mindset has the potential to accelerate its use and widespread adoption in educational research and practice.

The session is novel because it gives participants a unique opportunity to: (1) pose questions about the 3Cs framework and its components, including how we sourced the high-level constructs being presented, (2) connect their personal and professional experiences with the framework to the identified constructs shared, and (3) provide opinions on the constructs to identify grounding principles that can bolster ongoing efforts to foster entrepreneurial mindset among engineering students. This session also holds significance as it contributes to streamlining scholarly publications based on the 3Cs framework, benefiting researchers both within KEEN and beyond.

### IV. AGENDA AND EXPECTATIONS

The session facilitators will begin this highly interactive eighty-minute session by introducing themselves and providing an overview of the session flow, including the use of the web-based survey tool, Poll Everywhere [15], which will be used to gather participants' thoughts and feedback (5 minutes).

Next, participants will break into small groups for multiple rounds of consensus-building activities. These activities will involve: (1) rating their agreement with items representing high-level constructs associated with curiosity, connections, and creating value, and (2) engaging in peer-to-peer interaction to explain their individual perspectives and reach a collective understanding of each C. The items will be based on emerging findings from our scoping literature review. This iterative process of selecting options will be repeated to gain consensus among participants (20 minutes per C, or 60 minutes total).

The facilitators will then present a brief overview of the process that led to the identified items for each C, including insights from the content analysis of the Engineering Unleashed website, interviews with KEEN leaders, and scoping literature reviews (10 minutes). The session will conclude with a whole-group discussion where participants can ask questions about the study (5 minutes).

Participants should expect to interact with one another and with technology throughout the session. A smartphone or laptop is highly encouraged. Consent to participate in human-subjects research and to have their Poll Everywhere responses used as data will be collected via an online Qualtrics survey [16] at the beginning of the session. Participants will create a unique identifier to link their consent form with their responses during this process. This special session is approved by the Institutional Review Board at Rowan University under protocol PRO-2022-190. Participation in the research is not required to participate in the session, and participants can leave the session and/or withdraw their data from the research at any time.

### V. EXPECTED OUTCOMES

Participants will leave this session with a deeper understanding of how the 3Cs framework aligns with broader theoretical perspectives regarding curiosity, connections, and creating value, as highlighted in the existing literature. They will also have contributed to developing a literature and community-based foundation for the 3Cs framework that incorporates practitioner feedback. These outcomes offer a unique opportunity for participants to discuss how to effectively leverage the 3Cs framework in program development, assessment, and research on the development of an entrepreneurial mindset. This session could also attract a new and diverse group of researchers to the study of entrepreneurial mindset and the 3Cs, fostering networking for future research projects, collaborations, and funding proposals.

The facilitation team will leave this session with additional data to further develop its literature and community-based foundation for the 3Cs framework. Once complete, we will produce a set of references that are expected to be highly cited by those conducting scholarship framed by the 3Cs, thereby strengthening their research and fulfilling one of our initial

motivations for undertaking this work. Additionally, we will use a mix of traditional and innovative approaches to disseminate the findings of our work to relevant communities beyond fellow researchers. Specifically, we will reach those associated with KEEN through the resources that KEEN provides (e.g., cards created on the Engineering Unleashed website); members of the entrepreneurship education community through their archival publications and events; and the broader public through the production of short, easily digestible articles and/or videos.

## VI. FACILITATION TEAM

The facilitation team is currently engaged in a Kern Family Foundation-funded project to conduct the research described in this paper. The team includes four investigators and three graduate students from four institutions, three of which are KEEN partner schools. Brief bios and roles for each team member are outlined below.

Dr. Cheryl Bodnar (Principal Investigator) is an Associate Professor at Rowan University in the Experiential Engineering Education (ExEED) department. She has been active in entrepreneurship education research for the past ten years, with thirteen peer-reviewed journal articles, e.g., [17]-[20], and nineteen peer-reviewed conference papers, e.g., [10], [21]-[24], published on the subject. PI Bodnar serves on the KEEN Leadership Council, is a KEEN Leader at Rowan University, and has been recognized as a KEEN Rising Star. She coordinates all research and dissemination activities for the current project and co-leads the scoping literature review component.

Dr. Samantha Brunhaver (Co-Principal Investigator) is an Associate Professor at Arizona State University in The Polytechnic School within the Fulton Schools of Engineering. She has been involved in entrepreneurship education research for the last eight years and has published two peer-reviewed journal articles [7]-[8] and seven peer-reviewed conference papers on the topic, e.g., [25]-[28]. Co-PI Brunhaver serves as a KEEN Leader for ASU, has been identified as a KEEN Rising Star, and co-authored the abovementioned preliminary framework for the KEEN 3Cs [7]. She co-leads the scoping literature review component of the current project.

Dr. Adam Carberry (Co-Principal Investigator) is Professor and Department Chair of Engineering Education at The Ohio State University. He has been engaged in entrepreneurship education since 2016, having integrated entrepreneurial mindset activities into his design courses and co-authored two peer-reviewed journal articles [7]-[8] and three peer-reviewed conference papers [10], [25], [28] on the subject. He is a KEEN Leader for OSU, co-edited a special issue examining current practices in engineering entrepreneurship education [29], and co-authored the abovementioned preliminary framework for the KEEN 3Cs [7]. He co-leads the Delphi component of the current project.

Dr. Prateek Shekhar (Co-Principal Investigator) is an Assistant Professor of Engineering Education in the School of Applied Engineering and Technology at the New Jersey Institute of Technology and past Program Chair of the Entrepreneurship and Innovation Division of ASEE. He has

published multiple peer-reviewed journal articles and conference papers, e.g., [20], [30]-[32], on topics related to entrepreneurship education, winning the Best Research Paper (2nd place) and Best New Idea Paper (1st place) awards for the Entrepreneurship and Innovation Division in 2019. He co-leads the Delphi component of the current project.

Alexandra Jackson (Researcher) is a Ph.D. candidate in the Experiential Engineering Education (ExEED) department at Rowan University. She began her research at Rowan in the fall of 2019 and has research interests in entrepreneurial mindset and student development. She first-authored four peer reviewed journal articles, e.g., [18], [19], and co-authored seven peer reviewed conference papers, e.g., [10], [21], [24]. She has coordinated the Delphi data collection and organization component of the study and is currently leading the authorship of the scoping literature review component.

Sanjeev Kavale (Researcher) is a Ph.D. student in the Engineering Education and Systems Design doctoral program at Arizona State University. He worked prior to his Ph.D. studies as an engineering educator at KLE Technological University in India, where he designed and instructed first-year engineering courses utilizing interdisciplinary, design-based, project-based, and blended learning. His current research interests focus on the importance of mindsets in engineering education, and specifically, research mindset among engineering doctoral students.

Brendan Rucci (Researcher) is a recent graduate of the Biomedical Engineering master's program at Rowan University and currently works as a professional engineer. His previous research focuses on gold nanoparticle engineering. He is also interested in exploring aspects of entrepreneurial engineering education through this project. He has assisted in the scoping review component of this study through interrater examination of the individual articles.

## VII. ACKNOWLEDGMENTS

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