

## Conceptualizing Entrepreneurial Mind-set: Definitions and Usage in Engineering Education Research

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## **Conceptualizing the Entrepreneurial Mindset: Definitions and Usage in Engineering Education Research**

**Abstract:** In undergraduate engineering education, students are being increasingly exposed to entrepreneurship education through formal and informal programs. These contemporary programs have shifted from the traditional business-focused goal of venture creation to developing entrepreneurially minded engineers for a 21st century technology-driven global economy. To better design and implement these programs, it is critical to identify and assess their intended student learning outcomes. However, there is a lack of common ground among the engineering entrepreneurship community of researchers and practitioners on the intended outcomes of these programs, particularly with respect to entrepreneurial mindset. Our work attempts to better conceptualize how entrepreneurial mindset has been operationalized in current engineering assessment literature. We compare and contrast the current usage of ‘entrepreneurial mindset’ to identify similarities and inconsistencies in the conceptualization of the entrepreneurial mindset in recent engineering education literature and present implications of these findings for the engineering entrepreneurship community.

### **Introduction**

Recently, entrepreneurship has gained significant traction in undergraduate engineering education. Pushing beyond the goal of venture creation, engineering entrepreneurship programs are placing an emphasis on developing more entrepreneurially minded students by actively involving students in the learning process [1]. As these programs grow and expand across institutions, there is a growing need to better understand how to assess engineering entrepreneurship student outcomes. Such findings can be used to evaluate program impact and inform program and curricular development. Engineering entrepreneurship programs claim to develop student business knowledge and influence skills and attitudes, such as creativity, opportunity identification, and risk taking [2], [3]. These broad characteristics are often referred to as the ‘entrepreneurial mindset’ which encompasses business-related skills (e.g. opportunity identification and identifying user needs) as well as professional traits such as problem-solving, innovativeness, planning and decision-making [4]. Although there is increasing agreement in the field that entrepreneurial mindset is a key outcome of engineering entrepreneurship education, there is limited consensus on what entrepreneurial mindset is and what its key constituents are.

As the engineering entrepreneurship community grows and seeks to assess student outcomes and instructional impact of engineering entrepreneurship programs at scale, the community needs to be more consistent in defining and using the term entrepreneurial mindset [5]. A consistent definition will assist in ensuring alignment between curriculum, instruction and student learning outcomes; enhancing the validity and reliability of assessment efforts examining entrepreneurial mindset; and consequently, facilitate the development of more targeted entrepreneurship education programs for engineers. Our paper contributes to filling this research gap by focusing on developing an understanding of how the term entrepreneurial mindset (EM) has been conceptualized and framed in

engineering education research (EER) assessment literature. The findings of our work provide researchers and practitioners with a synthesized starting point as the field moves towards thinking more critically about entrepreneurial mindset and utilizing more research-based practices for program development and assessment.

## **Background**

Entrepreneurship education was first introduced into United States higher education after the second world war (1945-47) at the Harvard Business School [6], [7]. As entrepreneurial activity declined over the next two decades, Harvard eventually terminated the course [7]. But interest in entrepreneurship was renewed with the growth of the venture capital community [8] and by 1970, sixteen universities were offering entrepreneurship courses [7]. Entrepreneurship education experienced significant subsequent growth with over 2,200 entrepreneurship courses offered at 1,600 colleges and universities by 2003 [6]. This drastic increase is likely a result of the role startups had come to play in economic growth and employment [9].

With the advent of the technology-driven economy, the number of innovative startups transforming scientific discoveries into commercialized products continues to increase; providing additional motivations for including entrepreneurial training in higher education. As a result, entrepreneurship education has spread laterally to non-business disciplines such as engineering, technology, science, and arts [10]. This expansion has led to an evolution of entrepreneurship education from the business school model of venture creation to focus on developing skills in graduates that foster innovation in their career pursuits which may or may not involve self-employment [11]. Particularly in engineering, several curricular and co-curricular entrepreneurship programs have been initiated which typically use student-centered, experiential learning approaches to impart content knowledge and more importantly develop entrepreneurship-related skills in engineering graduates [12].

As entrepreneurship education continues to grow and evolve in engineering fields, it becomes crucial to work towards attaining alignment between curriculum, pedagogy, and assessment in engineering entrepreneurship programs. While educators are expected to be responsible for developing ‘discovery, reasoning, and implementation skills’; the research community needs to focus on critically answering the question ‘how do you teach people to think entrepreneurially or develop an entrepreneurial mindset?’ [13]. The fundamental step for determining effective pedagogical approaches and assessing engineering entrepreneurship education is building a coherent understanding of entrepreneurial mindset (EM). Although EM has increasingly becoming a commonly used term to describe the developmental goals of entrepreneurship education for undergraduate engineering programs, the conceptualization of the EM is still broad and varied. This is primarily because entrepreneurship education in engineering has utilized a wide variety of approaches such as standalone seminars introducing practicing entrepreneurs; project-based courses exposing students to the opportunity identification and customer discovery aspects of entrepreneurship; or student accelerators/incubators and other co-curricular programming for fostering student ventures [14], [15].

In other words, although the student-centered and cognition-oriented shift seen in the growth of engineering entrepreneurship education is laudable [16], it also contributes to varied conceptualizations of EM which consequently makes it difficult to assess the entrepreneurial mindset. Our work focusses on understanding the various ways entrepreneurial mindset has been conceptualized in engineering entrepreneurship assessment literature. The findings provide important implications for engineering entrepreneurship research as the field moves towards systematically assessing the impact of entrepreneurship education exposure [17]–[19].

## Methodology

For our presented work, we performed a systematic search and review of engineering entrepreneurship assessment literature that explored the concept of entrepreneurial mindset. The ‘systematic search and review’ method combines the strengths of systematic (e.g. [20]) and narrative literature reviews (e.g. [21]) by subjecting the results of a comprehensive search to a critique or conceptual analysis [22]. The result of this review process is a “more complete picture of the prevalence of research on a topic” [22].

On September 3, 2015, we conducted a systematic search of literature pertaining to entrepreneurship education assessment in two databases (Proquest’s ERIC/ABI/INFORM and Elsevier’s Scopus) that include engineering, business and education literature. The search terms [("entrepreneurship education" OR "entrepreneurial education") AND ("measurement" OR "instrument" OR "assessment")] were entered for all fields to include a wider breadth of papers. Only peer reviewed journal articles and conference proceedings focusing on entrepreneurship in higher education contexts were included. Systematic search methodology and detailed results of the review are described elsewhere [23]. Summary of the search is presented in Table 1.

**Table 1: Summary of systematic literature search**

Stage of review	Number of Citations	Details
Initial Search	3,123	1,780 and 1,343 from Proquest and Scopus respectively
Removal of duplicates	2,841	Number of duplicates were 282
Application of Inclusion criteria	359	Only non-empirical studies in higher education settings

For this paper, articles that specifically addressed EM in engineering were extracted from the final data set of 359 articles. We purposefully followed a liberal approach in order to capture a wide range of articles that discuss EM in an engineering context. Thus, all engineering entrepreneurship articles that included the term ‘mindset’ in either the title, abstract or full text were selected. The search yielded 19 articles for this review. Examination of full texts identified 10 articles that included the term ‘mindset’ in their full text but did not talk about EM per se. Since our focus was on how EM has been used in engineering education research rather than the frequency of its use, these 10 articles were excluded for this review. The resultant 9 articles were examined to compare and

contrast the ways in which the authors used EM. The focus of this examination was not on the outcomes of the studies, but rather on building an understanding of how EM has been conceptualized in the literature. A focused coding approach was used to capture different attributes relevant to the ways in which EM was conceptualized in the studies. These attributes included *how* EM was conceptualized, in *what* context and *why* based on the sources that guided the studies.

## **Findings and Discussion**

For the identified articles, we examined key similarities and differences in the ways researchers conceptualized EM. We found that researchers used a variety of closely related and often partially overlapping conceptualizations of EM. Three noteworthy areas were identified during this examination. First, we noted that the most visible differentiating factor among the used conceptualizations of EM was the definition of term ‘mindset’ itself – whether EM is a set of skills or attitudes. Second, in addition to differences in the definition of mindset, there were differences in whether EM was associated with workplace success or succeeding in performing various entrepreneurial tasks. Third, we noted that these inconsistencies may be due to differences in the sources that informed the study and conceptualizations of EM. These findings are presented in the sections below.

### ***Entrepreneurial Mindset – skills or attitudes?***

In the examined articles, we noted that the researchers conceptualized EM as a set of attitudes, differentiating it from entrepreneurial skills. While the definitions of attitude and skill are debatable themselves, we did not impose our definitions but rather examined the way they were referred to in EM context by the authors. For example, Boulanger & Tranquillo [24] described EM as a set of attitudes and clearly differentiated it from entrepreneurial skills or knowledge taught in traditional business courses. Specifically, the researchers stated, “entrepreneurial mindset is distinct from skills and knowledge needed to execute an entrepreneurial venture, and is rather a set of attitudes” [24, p. 3]. Along similar lines, Täks, Tynjälä, Toding, Kukemelk, & Venesaar [25] described EM as an orientation towards entrepreneurial activities, such as dealing with uncertainty and change, and pursuing innovation. The authors treated EM as different from knowledge or skills and highlighted the importance of fostering EM in addition to workplace skills in students.

In contrast, several researchers associated EM with skills. In one such study, Brown, Williams, Julia, & Sipes [26] described EM as a set of abilities and conceptualized them not only from a venture creation perspective but also included skills that graduating engineering students need for succeeding in any engineering career path. In another example, focusing on instilling ‘action-oriented’ EM in undergraduate students, Gerhart & Carpenter [27] associated EM with a set of skills such as creativity, innovativeness and critical thinking. Similarly, other researchers presented EM as a reasonable substitute for entrepreneurial skills [28], [29].

In other articles, researchers included specific traits in addition to skills in their descriptions of EM. In one example, Pistrui, Layer, & Dietrich [30] argued that EM is not specifically associated with an entrepreneur but rather with other professionals such as engineering students who can think entrepreneurially. To include this argument, EM was conceptualized as an integration of students' skills, behaviors and motivators. Also, Zappe [31] used a description of EM that conceptualized EM as the collection of "attributes, skills, and proficiencies that are 'indicative of an entrepreneurial mindset'" [31, p. 5]. Green & Johnston [32] included both entrepreneurial attitudes and skills (e.g. communication and interpersonal skills) in their conceptualization of EM.

### *Defining Terminology*

In addition to variations in the conceptualization of EM as either a set of skills or skills, another difference that was emergent in the examined articles was whether EM catered to general professional/workplace success or specifically to being successful in various entrepreneurial processes. Similar to the previous section, the conceptualizations of EM presented in the articles centered on either workplace success, or success in entrepreneurial processes, or a combination of both. For example, focusing on workplace success of graduating students, Brown et al. [26] associated EM with professional skills such as the ability to work effectively in teams, develop and solve problems, and take leadership roles.

In comparison, several researchers placed emphasis specifically on various stages of entrepreneurial processes, particularly those related to venture creation. For instance, Green & Johnston [32] conceptualized EM as a collection of psychosocial factors, which are important to the entrepreneurial opportunity discovery process. This collection of factors was related to a wide array of areas such as interpersonal skills, need for achievement, and self-efficacy. In another study, Boulanger & Tranquillo [24] focused on developing EM in students by engaging them in a learning environment that blends design and entrepreneurship. To foster the development of EM, the authors placed emphasis on engaging students in entrepreneurial processes such as opportunity recognition, examination of customer needs, and field observations. Similarly, other researchers centered their conceptualizations of EM on a variety of entrepreneurial processes including, but not limited to, opportunity orientation, value proposition, proactive decision-making, risk-taking, dealing with uncertainty and business acumen [25], [28], [30].

Lastly, in some articles, researchers' conceptualization approach was inclusive of both generic workplace and specific entrepreneurial process-oriented attributes. In one such work, Gerhart & Carpenter [27] associated EM with professional skills such as communication, teamwork, creativity and leadership; and entrepreneurial process-oriented skills such as marketing, tolerance for ambiguity and risk analysis. Similarly, Zappe [31] related EM to business acumen as well as creativity and communication skills. Along similar lines, Reid & Ferguson [29] focused on students' mindset towards risk and also on creativity and innovativeness in completing project tasks.

## *Guiding Sources*

In the sections above, we presented the differences and similarities in the ways researchers 1) conceptualized EM in terms of skills or attitudes, and 2) associated EM with general professional success or specifically with proficiency in performing different entrepreneurial processes or entrepreneurship-related tasks. Overall, there was a lack of consistency in the conceptualizations of EM with authors describing EM as skills and/or attitudes. Also, there was lack of consensus on whether EM is associated with students' ability to successfully perform workplace tasks or various tasks involved in the entrepreneurial process. In other words, in the identified engineering entrepreneurship articles, the authors conceptualized EM in a variety of ways indicating minimal or no agreement on the definition of EM in engineering entrepreneurship research. While these findings identify important areas of disparity in the conceptualization of EM emergent in engineering entrepreneurship literature, we also examined what sources were guiding these conceptualizations in the identified articles. One plausible reason behind these disparities is that guiding sources emerged from different views about the purpose of engineering entrepreneurship education. For the purpose of our analysis, we grouped these sources into three categories: engineering entrepreneurship literature (e.g. KEEN and ASEE), national reports (e.g. NAE) and existing business literature/instruments.

In most of the studies, the conceptualizations were guided by sources from at least two of the three source categories (Table 2). For example, in studies using national reports as one of their guiding sources, EM was associated with workplace success (e.g. [26], [29]). On the other hand, studies using business literature and/or instruments as their guiding sources associated EM with succeeding in the various stages of entrepreneurial processes (e.g. [25], [32]).

While national reports are drivers for change, the nascent state of engineering entrepreneurship assessment means it is often informed by prior work in the areas of education, business, and learning sciences. While education and learning science theories may hold direct applicability to entrepreneurship teaching and learning, business literature may be less applicable due to differences in the desired learning outcomes between the two fields. For example, while entrepreneurship in business fields is primarily associated with venture creation, engineering entrepreneurship education places emphasis on instilling workplace skills such as innovativeness and creativity in students. This is because engineering entrepreneurship programs have developed in response to national reports calling for improving undergraduate teaching and learning to prepare students for future workplace challenges.

Thus, while it is good practice to use prior work to inform research design and data collection, complete reliance on entrepreneurship literature from business fields may lead to misalignment with the intended outcomes of engineering education reforms. In addition, although the engineering entrepreneurship community (e.g. ASEE and KEEN) has provided a platform for researchers to interact and collaborate on improving various assessment-related areas, a lack of communication of desired learning outcomes and their conceptions can lead to further promulgation of terminologies such as EM in the

community without any concrete description of what they entail in the broader realm of engineering entrepreneurship education.

**Table 2: Summary of articles**

<i>Reference</i>	<i>Entrepreneurial Mindset – skills or attitudes?</i>	<i>Defining Terminology</i>	<i>Guiding Sources</i>
Boulanger & Tranquillo [24]	Attitudes	Entrepreneurial process	Engineering entrepreneurship literature
Brown et al. [26]	Attitudes and skills	Workplace success	Engineering entrepreneurship literature and National Report
Green& Johnston [32]	Attitudes and skills	Entrepreneurial process	Engineering entrepreneurship literature and Business Literature/Instruments
Gerhart & Carpenter [27]	Skills	Workplace success and Entrepreneurial process	Engineering entrepreneurship literature
Pistrui et al. [30]	Skills, behaviors and motivators	Entrepreneurial process	Engineering entrepreneurship literature
Taks et al. [25]	Attitudes	Entrepreneurial process	Business Literature/Instruments
Reid et al. [29][33]	Skills	Workplace success and Entrepreneurial process	National Report and Business Literature/Instruments
Reeves & Pennsylvania [28]	Skills	Entrepreneurial process	Engineering entrepreneurship literature
Zappe [31]	Skills and Attitudes	Workplace success and Entrepreneurial process	Business Literature/Instruments

## Conclusion

Engineering entrepreneurship research lies at the intersection of multiple disciplines, including but not limited to engineering, business, and educational psychology. The cross-disciplinary nature of the field offers significant potential to use knowledge from different disciplines to improve teaching and learning in engineering entrepreneurship programs. However, it is difficult to collaborate due to the presence of divergent worldviews and conceptual differences among researchers who have been cultured in different academic milieus. For example, due to disciplinary differences, it is highly



likely that a term in one field may have different meanings and implications in other fields. Our presented work highlights this challenge by identifying inconsistencies in the conceptualization of the entrepreneurial mindset in recent engineering education literature and reiterates the need for a common taxonomy in engineering entrepreneurship community.

It is critical to understand that proposing a common taxonomy is not meant to limit the scope of engineering entrepreneurship education, but to facilitate more robust research and understanding of engineering entrepreneurship. It will be a platform that can be used across disciplines as the community looks to implement more evidence-based practices that impact entrepreneurship education. With common definitions, researchers can determine the appropriate psychological theories that can be applied to engineering entrepreneurship research and assessment and examine the underlying assumptions made in assessment development. This will help researchers determine the engineering-appropriate constructs that should be measured and identify where previously developed constructs can be leveraged; or where new constructs must be developed and tested for validity and reliability. Critical evaluation of construct development is necessary as the most commonly used entrepreneurship scales have been developed in the context of business creation among business students. As engineering entrepreneurship education continues to evolve into its own unique field and encompass a wider scope beyond new venture creation, it is critical to reflect on this evolution in research and assessment development.

As the research community collaborates to formalize a common definition of EM, we advocate that this should not stop practitioners from assessing student-learning outcomes in their ongoing entrepreneurship programs. Although the findings of our work highlight inconsistencies in the conceptualization of EM, they also provide a list of ways in which EM can be conceptualized. Practitioners may select the conceptualization that best suits their course's desired learning outcomes and assess the underlying constructs accordingly. For example, an instructor aiming to instill workplace skills in students through a project-based course may use instruments measuring skills such as problem solving and teamwork to perform the assessment. Similarly, instructors who want to change students' attitudes by exposing them to guest speakers in an entrepreneurial seminar course may use instruments that examine students' attitude towards starting a company in their assessment process. Such assessment results will help practitioners better design course content and pedagogy to meet the desired learning outcomes, and also simultaneously provide the research community with data to identify which conceptualizations or constituent constructs of EM are most frequently targeted in current engineering entrepreneurship programs.

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