

Bridging the Entrepreneurial Mindset Profile (EMP) and KEEN Framework: Toward a Cross-Disciplinary Assessment and Development Tool

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1. Introduction

The entrepreneurial mindset has emerged as an increasingly important competency in engineering education. Modern engineers are expected not only to apply technical knowledge but also to recognize opportunities, create value for stakeholders, and navigate uncertain environments characterized by rapid technological and societal change. As a result, engineering programs across the United States have begun integrating entrepreneurship-oriented learning outcomes into their curricula.

The Kern Entrepreneurial Engineering Network (KEEN) has played a central role in advancing this shift by promoting educational practices that cultivate entrepreneurial thinking among engineering students. KEEN conceptualizes entrepreneurial mindset through three core constructs—Curiosity, Connections, and Creating Value—which together describe the behaviors and attitudes associated with innovative engineering practice [1]. Curiosity encourages students to explore problems deeply and question assumptions, Connections emphasizes integrating knowledge across disciplines and stakeholders, and Creating Value focuses on translating insights into solutions that produce meaningful impact.

Recent KEEN faculty development initiatives have further emphasized two additional dimensions that support entrepreneurial thinking in engineering contexts: Action Orientation and Self-Awareness. Action Orientation reflects the importance of experimentation, prototyping, and learning through action, while Self-Awareness highlights reflective thinking and understanding how personal strengths and limitations influence decision-making [1]. Together, these constructs represent a developmental framework for cultivating entrepreneurial mindset in engineering education.

Despite the growing adoption of the KEEN framework, one important limitation remains: the absence of a validated psychometric instrument designed specifically to measure entrepreneurial mindset outcomes associated with KEEN learning objectives. While educators frequently use project rubrics, reflective assignments, and qualitative evaluation methods, these approaches often lack the reliability and comparability required for systematic assessment across courses or institutions.

In contrast, entrepreneurship research has developed several psychometric instruments designed to measure entrepreneurial cognitive and behavioral tendencies. One of the most widely validated among these is the Entrepreneurial Mindset Profile (EMP), developed by the Leadership Development Institute at Eckerd College. The EMP assesses fourteen dimensions associated with entrepreneurial cognition and behavior, derived from empirical research comparing successful entrepreneurs with corporate managers [6].

Although the KEEN framework and the EMP instrument originate from different scholarly traditions—engineering education and entrepreneurial psychology—the constructs they describe exhibit substantial conceptual overlap. This observation raises an important question for engineering education research:

To what extent do the constructs measured by the Entrepreneurial Mindset Profile align with the entrepreneurial mindset dimensions articulated in the KEEN framework?

Addressing this question may help bridge the gap between educational frameworks designed to cultivate entrepreneurial thinking and psychometric instruments capable of measuring it. Accordingly, this study examines empirical relationships between the fourteen EMP constructs and five KEEN composite dimensions derived from theoretical mapping. Using assessment data from undergraduate students, the analysis evaluates correlations among these constructs and interprets the results relative to entrepreneurial norm benchmarks embedded in the EMP instrument.

By connecting a validated entrepreneurial mindset assessment with a widely adopted engineering education framework, the study provides an initial step toward developing a more systematic and scalable approach to evaluating entrepreneurial mindset development in engineering programs.

2. Literature Review

2.1 Entrepreneurial Mindset in Engineering Education

Engineering education research increasingly emphasizes the importance of preparing students to operate in complex environments that require creativity, interdisciplinary collaboration, and value creation. Traditional engineering curricula have historically focused primarily on technical problem solving. However, contemporary engineering practice increasingly demands the ability to identify opportunities, integrate diverse knowledge domains, and design solutions that address societal needs.

Scholars have argued that developing adaptive expertise and reflective practice is essential for preparing engineers to navigate uncertain and evolving technological landscapes [2], [5]. Pedagogical approaches emphasizing experiential learning, design thinking, and project-based collaboration have therefore become increasingly common in engineering programs [3], [4].

Within this context, the KEEN framework has emerged as a widely adopted model for cultivating entrepreneurial mindset in engineering education. The framework encourages students to approach engineering problems through curiosity-driven inquiry, integrative thinking, and value-oriented design. These competencies align closely with research on innovation and opportunity recognition in entrepreneurship literature, where identifying connections between disparate information sources often leads to new venture opportunities [17].

2.2 The Entrepreneurial Mindset Profile (EMP)

The Entrepreneurial Mindset Profile (EMP) represents one of the few psychometrically validated instruments designed specifically to measure entrepreneurial thinking. Developed by the Leadership Development Institute at Eckerd College, the EMP evaluates fourteen dimensions that reflect both personality tendencies and cognitive-behavioral capabilities associated with entrepreneurial performance [6].

The instrument includes fourteen constructs organized into two categories: personality-based tendencies and skill-based capabilities (Figure 1). These constructs were identified through empirical analysis of more than seven hundred assessment profiles and interviews involving successful entrepreneurs and corporate managers. The objective of the original research was not to identify traits that entrepreneurs possess in greater magnitude, but rather to identify patterns that differentiate entrepreneurial cognitive profiles from managerial ones.

Entrepreneurial Mindset Profile® (EMP) Scales	
Personality Scales—The Who and the Why	
Independence	The desire to work with a high degree of independence
Preference for Limited Structure	A preference for tasks and situations with little formal structure
Nonconformity	A preference for acting in unique ways; an interest in being perceived as unique
Risk Acceptance	A willingness to pursue an idea or a desired goal even when the probability of succeeding is low
Action Orientation	A tendency to show initiative, make decisions quickly, and feel impatient for results
Passion	A tendency to experience one's work as exciting and enjoyable rather than tedious and draining
Need to Achieve	The desire to achieve at a high level
Skills Scales—The What and the How	
Future Focus	The ability to think beyond the immediate situation and plan for the future
Idea Generation	The ability to generate multiple and novel ideas, and to find multiple approaches for achieving goals
Execution	The ability to turn ideas into actionable plans; the ability to implement ideas well
Self-Confidence	A general belief in one's ability to leverage skills and talents to achieve important goals
Optimism	The ability to maintain a generally positive attitude about various aspects of one's life and the world
Persistence	The ability to bounce back quickly from disappointment, and to remain persistent in the face of setbacks
Interpersonal Sensitivity	<i>A high level of sensitivity to and concern for the well-being of those with whom one works</i>

Figure 1: Entrepreneurial Mindset Profile (EMP) scales

A key feature of the EMP framework is the use of entrepreneurial norm benchmarks derived from experienced entrepreneurs. These norms provide a reference point for interpreting assessment results. Importantly, entrepreneurial performance is not associated with maximizing individual trait scores. Instead, successful entrepreneurs tend to exhibit balanced profiles in

which certain tendencies are neither overplayed nor underplayed relative to entrepreneurial norms.

For example, the entrepreneurial norm for Nonconformity reflects a moderate tendency to challenge existing assumptions without becoming purely rebellious. Similarly, Independence scores among experienced entrepreneurs tend to be lower than popular narratives might suggest, reflecting the collaborative nature of venture development and organizational growth. These patterns illustrate that entrepreneurial mindset is better understood as a calibrated configuration of tendencies rather than an extreme expression of particular personality traits.

2.3 Conceptual Alignment Between EMP and KEEN

Although the KEEN framework and the Entrepreneurial Mindset Profile (EMP) emerge from different scholarly traditions—engineering education and entrepreneurial psychology, respectively—their constructs show substantial conceptual overlap. KEEN was designed as a pedagogical framework to cultivate entrepreneurial thinking among engineering students, whereas the EMP was developed as a psychometric instrument to identify cognitive, behavioral, and dispositional patterns associated with successful entrepreneurs [1], [6]. The present study builds on the premise that these two frameworks, while distinct in purpose, may describe related dimensions of entrepreneurial mindset.

The first point of alignment concerns Curiosity. In the KEEN framework, curiosity emphasizes questioning, exploring, and actively seeking new information [1]. This construct maps naturally onto several EMP dimensions associated with exploratory cognition, including Idea Generation, Future Focus, and, to a lesser extent, Need to Achieve. Opportunity recognition research suggests that entrepreneurs identify possibilities by connecting information, imagining alternatives, and noticing patterns that others overlook [17]. Creativity research similarly highlights divergent thinking and ideational fluency as essential to entrepreneurial cognition [12], [23]. In engineering education, these same processes appear in problem framing, ideation, and exploratory design reasoning [5], [24]. For this reason, EMP scales associated with imagination, future-oriented thinking, and exploratory cognition provide a defensible theoretical basis for approximating KEEN Curiosity.

A second major point of overlap involves Connections, which KEEN defines as integrating knowledge across domains, perspectives, and stakeholder groups [1]. This construct corresponds closely with the social and relational dimensions of entrepreneurial work. Entrepreneurship research shows that opportunity development is rarely an isolated cognitive act; instead, it is shaped by networks, stakeholder interactions, and the entrepreneur's ability to understand and respond to social cues [11], [27]. Similarly, engineering education scholars have emphasized that meaningful design work depends on understanding users, framing problems collaboratively, and synthesizing technical and non-technical perspectives [5], [26]. These insights support the

alignment of Connections with EMP scales such as Interpersonal Sensitivity, Optimism, and Self-Confidence, which together reflect the socio-emotional and interpersonal capacities needed for collaborative innovation.

The KEEN construct of Creating Value aligns most strongly with EMP dimensions related to execution and sustained effort. In KEEN, creating value means transforming technical knowledge and insight into solutions that benefit stakeholders and society [1]. This emphasis corresponds closely with entrepreneurial research showing that successful venture creation depends not only on generating ideas, but also on implementing them, persisting through difficulty, and maintaining goal-directed effort [21], [25]. Within the EMP framework, Execution, Persistence, and Need to Achieve capture these implementation-oriented tendencies. Engineering education literature likewise treats prototyping, testing, iteration, and disciplined problem solving as central mechanisms through which ideas become valuable outcomes [5]. Thus, the relationship between these EMP scales and Creating Value is conceptually strong and theoretically well grounded.

The additional dimensions of Action Orientation and Self-Awareness, while not part of the original KEEN 3C formulation, have emerged in recent KEEN faculty development discussions as important complementary dimensions of entrepreneurial engineering practice [1]. Action Orientation reflects initiative, experimentation, and willingness to move ideas forward under uncertainty. This aligns directly with the EMP scale Action Orientation, and also with Execution, because both constructs involve moving from cognition to action [10], [32]. In entrepreneurship research, entrepreneurial behavior is often distinguished from managerial behavior precisely by this capacity to act under uncertainty and advance opportunities despite incomplete information [10], [14]. In engineering contexts, these same tendencies appear in rapid prototyping, iterative testing, and active design engagement [5].

Self-Awareness concerns reflective judgment, understanding one's strengths and limitations, and monitoring personal growth during entrepreneurial action. This dimension is consistent with research on entrepreneurial metacognition, which describes how entrepreneurs reflect on their own thinking, adapt to feedback, and regulate their decision-making processes [29]. Within the EMP framework, Self-Confidence and Optimism are particularly relevant here, as both shape how individuals assess their own capabilities and respond to obstacles [19]. In engineering education, reflective practice and self-regulation are similarly recognized as critical for adaptive expertise and learning in ambiguous environments [2], [5]. For this reason, these EMP scales offer a reasonable theoretical basis for representing Self-Awareness in the present study. Figure 2 summarizes this mapping.

KEEN Construct	EMP Scales
Curiosity	Idea Generation, Future Focus, Passion, Need to Achieve
Connections	Interpersonal Sensitivity, Optimism, Self-Confidence
Creating Value	Execution, Persistence, Need to Achieve

Action Orientation	Action Orientation, Risk Acceptance, Execution
Self-Awareness	Self-Confidence, Optimism, Interpersonal Sensitivity

Figure 2: EMP – KEEN Construct Mapping

At the same time, not every EMP dimension maps equally well onto KEEN. Some constructs—especially Independence and Preference for Limited Structure—occupy a more ambiguous position in the alignment. Entrepreneurship literature often associates these tendencies with early-stage entrepreneurial behavior, where founders must make decisions under high uncertainty and frequently operate without established routines [8], [10]. However, KEEN’s educational emphasis is more strongly oriented toward collaborative, stakeholder-informed, and value-driven problem solving. Rather than treating these constructs as central to the KEEN model, the present study treats them as theoretically relevant but empirically open dimensions whose relationship to KEEN constructs should be tested rather than assumed. This distinction is important because it allows the analysis to identify not only areas of convergence between entrepreneurial psychology and engineering mindset, but also areas where the frameworks may diverge in meaningful ways.

Taken together, this conceptual alignment provides the theoretical foundation for the empirical analysis that follows. The KEEN composites examined in this study were derived from EMP scales not arbitrarily, but through a literature-grounded interpretive mapping that links entrepreneurial cognition, engineering education, and opportunity-driven behavior. The resulting alignment does not claim that EMP and KEEN are identical frameworks. Rather, it proposes that the EMP may offer a useful psychometric lens through which KEEN-related entrepreneurial mindset development can be assessed and interpreted in engineering education settings.

While the previous section establishes conceptual alignment, the next section outlines how this alignment is operationalized empirically.

2.4 Analytical Approach for Cross-Framework Construct Alignment

While the KEEN framework and the Entrepreneurial Mindset Profile originate from different scholarly traditions, comparing constructs across conceptual frameworks is a common strategy in exploratory research aimed at identifying potential measurement alignment. Such approaches are frequently used when an established educational framework lacks a validated measurement instrument but shares conceptual territory with existing psychometric constructs.

In the present study, KEEN dimensions were operationalized by constructing composite variables derived from theoretically aligned EMP scales. This mapping process was grounded in the literature discussed above linking entrepreneurial cognition, creativity, opportunity recognition, and execution behavior with the competencies emphasized in entrepreneurial engineering education. Similar construct-alignment approaches have been used in studies examining relationships between entrepreneurial mindset constructs and broader psychological traits associated with innovation, opportunity recognition, and entrepreneurial behavior [6], [29].

To examine the relationships between these constructs, the study employs Pearson correlation analysis. Correlation analysis is commonly used in exploratory construct alignment research because it allows researchers to examine whether theoretically related constructs demonstrate empirical association in observed data [21]. When two conceptual frameworks describe related psychological or behavioral tendencies, meaningful correlations between their operationalized measures provide preliminary evidence that the constructs may capture overlapping dimensions of mindset or behavior. Importantly, such analyses do not establish causal relationships or psychometric validation; rather, they provide an empirical starting point for future scale development and confirmatory analysis.

An additional interpretive feature of this study involves the use of entrepreneurial norm benchmarks embedded in the EMP framework. Unlike many personality assessments that assume higher scores represent stronger traits, the EMP instrument was developed through comparative analysis of successful entrepreneurs and corporate managers. As a result, the entrepreneurial norm represents the typical profile observed among experienced entrepreneurs rather than an idealized maximum score across traits [6]. The scales that demonstrate higher differences between the entrepreneurial norm and the managerial norm comprehend the 14 selected for the EMP framework, no more, no less, since these are the characteristics that better differentiate entrepreneurs from non-entrepreneurs.

3. Methodology

3.1 Research Design

This study adopts an exploratory quantitative research design aimed at examining the empirical relationship between constructs measured by the Entrepreneurial Mindset Profile (EMP) and the dimensions of the KEEN entrepreneurial mindset framework. Because the KEEN framework does not currently include a validated psychometric assessment instrument, the analysis relies on a construct-alignment approach in which KEEN dimensions are operationalized through theoretically related EMP scales.

The purpose of this study is therefore not to validate the KEEN framework as a psychometric instrument, but rather to explore whether empirically measured entrepreneurial mindset dimensions captured by the EMP show meaningful alignment with KEEN constructs. By examining correlations between these constructs and interpreting them relative to entrepreneurial norm benchmarks, the study aims to provide preliminary evidence supporting the feasibility of integrating validated entrepreneurial psychology measures into engineering mindset assessment. Such exploratory construct-alignment approaches are commonly used as preliminary steps in instrument development and cross-framework comparison studies [6]. The empirical analysis focuses on examining correlations between the fourteen EMP scales and five composite variables representing KEEN entrepreneurial mindset dimensions.

3.2 The Entrepreneurial Mindset Profile Instrument

The Entrepreneurial Mindset Profile (EMP) was developed by the Leadership Development Institute at Eckerd College and is grounded in empirical research comparing the psychological characteristics of successful entrepreneurs and corporate managers [6]. The instrument was validated through large-scale survey research and qualitative interviews with more than 700 entrepreneurs and corporate managers.

Unlike many personality assessments, the EMP does not assume that higher scores necessarily represent stronger entrepreneurial capability. Instead, the instrument includes entrepreneurial norm benchmarks derived from the average scores observed among experienced entrepreneurs.

These benchmarks represent the behavioral profile commonly observed among entrepreneurs who have successfully built and sustained ventures. Importantly, the entrepreneurial norm reflects balanced levels of several psychological tendencies rather than extreme values, emphasizing that entrepreneurial effectiveness depends on moderation rather than maximization of particular traits.

For example, moderate levels of nonconformity support creative thinking without producing purely rebellious behavior, while moderate independence allows entrepreneurs to exercise strategic autonomy while still collaborating with teams and stakeholders. These normative benchmarks therefore provide an important interpretive lens for evaluating EMP results.

The Entrepreneurial Mindset Profile (EMP) was administered using its original validated itemized scales through the official online assessment platform. The EMP instrument produces scores on fourteen scales, each measured on a five-point Likert scale where scores represent the degree to which individuals demonstrate the tendencies measured by the instrument. These scales capture both dispositional tendencies and cognitive-behavioral capabilities associated with entrepreneurial thinking.

The fourteen EMP constructs included in the dataset are:

- Independence
- Preference for Limited Structure
- Nonconformity
- Risk Acceptance
- Action Orientation
- Passion
- Need to Achieve
- Future Focus
- Idea Generation
- Execution
- Self-Confidence
- Optimism

- Persistence
- Interpersonal Sensitivity

No KEEN-specific survey instrument was administered. Instead, KEEN construct scores were analytically derived by aggregating theoretically aligned EMP scale scores according to the conceptual mapping developed in Section 2.4. Thus, KEEN constructs in this study function as second-order composite variables derived from validated entrepreneurial constructs rather than directly measured survey scales. This approach enables the exploratory investigation of theoretical alignment between the two frameworks while maintaining the psychometric integrity of the EMP instrument.

3.3 Participant profiles

The dataset used in this study consists of 128 graduate and undergraduate students enrolled in entrepreneurship and innovation courses in two academic institutions: A mid-sized private university in the United States and a graduate program at a private university located in Sao Paulo, Brazil. Students represented multiple academic disciplines, including engineering, business, and related fields. The dataset combines EMP assessments administered across several course offerings during the 2025–2026 academic year. Participation in the assessment was voluntary and conducted within normal course instructional activities.

3.4 Construction of KEEN Composite Variables

The dataset was extracted from the EMP reporting system and consolidated into a structured database for analysis. Records containing incomplete assessments were removed to ensure data consistency. The resulting dataset contained 121 complete observations across all fourteen EMP scales.

Because KEEN constructs were derived from EMP dimensions, composite scores were calculated by averaging the relevant EMP scales associated with each KEEN construct. These composite constructs included Curiosity, Connections, Creating Value, Action Orientation, and Self-Awareness as follows:

Curiosity - Derived from EMP scales associated with exploratory cognition and opportunity recognition, described as: Idea Generation, Future Focus and Need to Achieve. These constructs capture creative ideation, future-oriented thinking, and motivational drivers associated with exploring new possibilities.

Connections - Derived from EMP scales associated with interpersonal awareness and relational integration. Described as: Interpersonal Sensitivity, Optimism and Self-Confidence. These constructs reflect the socio-emotional and relational competencies involved in integrating diverse perspectives and collaborating with stakeholders.

Creating Value - Derived from EMP scales associated with execution and sustained effort, described as: Execution, Persistence and Need to Achieve. These scales represent the behavioral capacity to transform ideas into implemented solutions.

Action Orientation - Derived primarily from the EMP Action Orientation scale and supported by Execution. These constructs represent the tendency to move from ideas to action under conditions of uncertainty.

Self-Awareness - Operationalized through reflective and self-evaluative constructs including Self-Confidence and Optimism, which influence how individuals evaluate their capabilities and respond to feedback.

To contextualize student scores relative to entrepreneurial benchmarks, the analysis also incorporated the official EMP Entrepreneurial Norm values established by the instrument developers. These norms represent the average profile of successful entrepreneurs identified during the original EMP validation process and provide a reference point for interpreting whether student scores reflect underplayed or overplayed tendencies relative to entrepreneurial populations.

In addition to supporting descriptive comparison, these entrepreneurial norm benchmarks provide an interpretive reference for understanding how student mindset profiles relate to patterns observed among experienced entrepreneurs.

3.5 Analytical Approach

The study employed Pearson correlation analysis to examine relationships between the fourteen EMP scales and the five KEEN composite constructs. Pearson correlation coefficients are appropriate for examining linear associations between continuous variables measured on Likert-type scales when the objective is to explore construct relationships rather than establish causal effects. This method is widely used in exploratory validation studies and psychometric construct alignment research.

Correlation analysis is particularly appropriate in this study because the objective is to evaluate whether constructs derived from two conceptual frameworks demonstrate empirical alignment in observed data. Moderate or strong correlations between theoretically aligned constructs provide preliminary evidence that the frameworks may capture overlapping aspects of entrepreneurial mindset.

The analysis proceeds in two stages:

1. Composite construction, in which KEEN variables are calculated as the average of their mapped EMP scales.
2. Correlation analysis, in which Pearson correlation coefficients are calculated between the fourteen EMP scales and the five KEEN composite variables.

Results are interpreted relative to commonly used guidelines for correlation strength, where values around 0.10 represent weak relationships, 0.30 moderate relationships, and 0.50 or higher strong relationships.

The analysis generated a correlation matrix comparing each EMP scale with each KEEN composite. A heatmap visualization was also produced to facilitate interpretation of the relationships among constructs. Because the purpose of this study is exploratory and theory-building rather than hypothesis testing, statistical significance thresholds were not emphasized. Instead, correlations were interpreted based on magnitude and theoretical consistency with entrepreneurship and engineering education literature.

In addition to correlation analysis, two complementary analyses were conducted to strengthen interpretation of the results. First, Cronbach's alpha reliability coefficients were calculated for each KEEN composite construct to evaluate internal consistency among the EMP scales used to form each composite. Second, a deviation analysis was performed comparing student mean scores on each EMP dimension with the official entrepreneurial norm values. This comparison represents the average profile of successful entrepreneurs and serves as a reference point for evaluating how closely student results resemble entrepreneurial cognitive patterns. Because the EMP framework emphasizes balanced trait expression rather than extreme values, deviations from the entrepreneurial norm may indicate areas where student mindset profiles differ from those typically observed among entrepreneurs.

This normative interpretation provides an additional analytical perspective for understanding correlations observed in the data. In particular, constructs whose entrepreneurial norm values are relatively moderate—such as independence and preference for limited structure—may exhibit weaker alignment with KEEN constructs that emphasize collaborative and structured problem solving.

By combining correlation analysis with normative interpretation, the study provides a richer understanding of how entrepreneurial mindset constructs measured through the EMP relate to the competencies emphasized in engineering entrepreneurship education.

4. Results

4.1 Descriptive Statistics

To contextualize the correlation analysis, descriptive statistics were calculated for all fourteen EMP scales and compared with the entrepreneurial norm benchmarks established in the EMP framework. Table 1 presents the sample means alongside these benchmark values.

EMP Scale	Student Mean	Entrepreneur Norm	Δ (Student – Norm)
Independence	2.45	2.56	-0.11
Limited Structure	2.54	2.93	-0.39

EMP Scale	Student Mean	Entrepreneur Norm	Δ (Student – Norm)
Nonconformity	3.45	3.75	-0.30
Risk Acceptance	3.52	4.05	-0.53
Action Orientation	3.66	3.90	-0.24
Passion	3.67	4.30	-0.63
Need to Achieve	4.13	4.33	-0.20
Future Focus	3.14	3.35	-0.21
Idea Generation	3.49	4.15	-0.66
Execution	3.42	3.96	-0.54
Self-Confidence	3.49	3.87	-0.38
Optimism	3.83	4.25	-0.42
Persistence	4.08	4.46	-0.38
Interpersonal Sensitivity	3.89	3.92	-0.03

Table 1. EMP Scale Descriptive Statistics and Entrepreneurial Norm Comparison

Across all fourteen dimensions, student scores are consistently below the entrepreneurial norm, with varying degrees of deviation. The smallest difference is observed for Interpersonal Sensitivity ($\Delta = -0.03$), indicating near alignment with entrepreneurial benchmarks. In contrast, larger deviations are observed for Idea Generation ($\Delta = -0.66$), Passion ($\Delta = -0.63$), and Execution ($\Delta = -0.54$).

This pattern suggests that while students demonstrate foundational elements of the entrepreneurial mindset, they have not yet reached the levels typically observed among experienced entrepreneurs, particularly in areas related to creative ideation, sustained motivation, and execution capability.

These descriptive results provide important context for interpreting the subsequent correlation analysis, particularly in understanding whether observed relationships reflect structural alignment between constructs or differences in developmental stage relative to entrepreneurial benchmarks.

4.2 Overview of Correlation Patterns

Pearson correlation coefficients were calculated to examine the relationships between the fourteen EMP scales and the five KEEN composite constructs. Pearson correlation was selected as an appropriate method for assessing linear relationships between continuous variables and is widely used in exploratory analyses of construct alignment. The full correlation matrix is presented in Table 2.

	Curiosity	Connections	Creating Value	Action Orientation	Self-Awareness
Independence	0.14611	-0.33295	-0.15700	-0.05741	-0.10662
Preference for Limited Structure	0.28042	-0.12025	-0.12538	-0.09296	-0.04103
Nonconformity	0.62474	-0.02090	0.31567	0.29919	0.29528
Risk Acceptance	0.35277	0.18683	0.35896	0.34127	0.44852
Action Orientation	0.35809	0.33227	0.60360	0.85342	0.47427
Passion	0.33958	0.45267	0.58788	0.37634	0.49796
Need to Achieve	0.24461	0.25706	0.73128	0.36237	0.42850
Future Focus	0.65612	0.35733	0.40146	0.25511	0.41315
Idea Generation	0.71622	0.17974	0.36482	0.47510	0.33900
Execution	0.54546	0.34930	0.81935	0.90486	0.57669
Self Confidence	0.47703	0.37554	0.67677	0.56929	0.87722
Optimism	0.43003	0.84471	0.57953	0.46752	0.85184
Persistence	0.50609	0.63305	0.87909	0.68000	0.76014
Interpersonal Sensitivity	0.02609	0.83570	0.27384	0.17993	0.30653

Table 2: EMP – KEEN Pearson correlation matrix

Across the dataset, several EMP scales demonstrated moderate to strong relationships with KEEN composites, indicating meaningful conceptual alignment between the psychometric constructs captured by the Entrepreneurial Mindset Profile and the behavioral mindset outcomes emphasized in the KEEN framework.

Two general patterns emerge from the analysis. First, multiple EMP dimensions associated with creativity, motivation, and execution show consistent positive relationships with KEEN constructs. Second, a small number of EMP constructs—particularly Independence and Preference for Limited Structure—show weak or near-zero correlations with KEEN outcomes. These divergent patterns provide important insight into the relationship between entrepreneurial psychology constructs and engineering-focused entrepreneurial mindset development.

4.3 Convergent Relationships Between EMP and KEEN Constructs

Several EMP scales display correlations that are theoretically consistent with the KEEN constructs to which they were mapped. Figure 3 presents a heatmap visualization to facilitate interpretation of relationships among constructs.

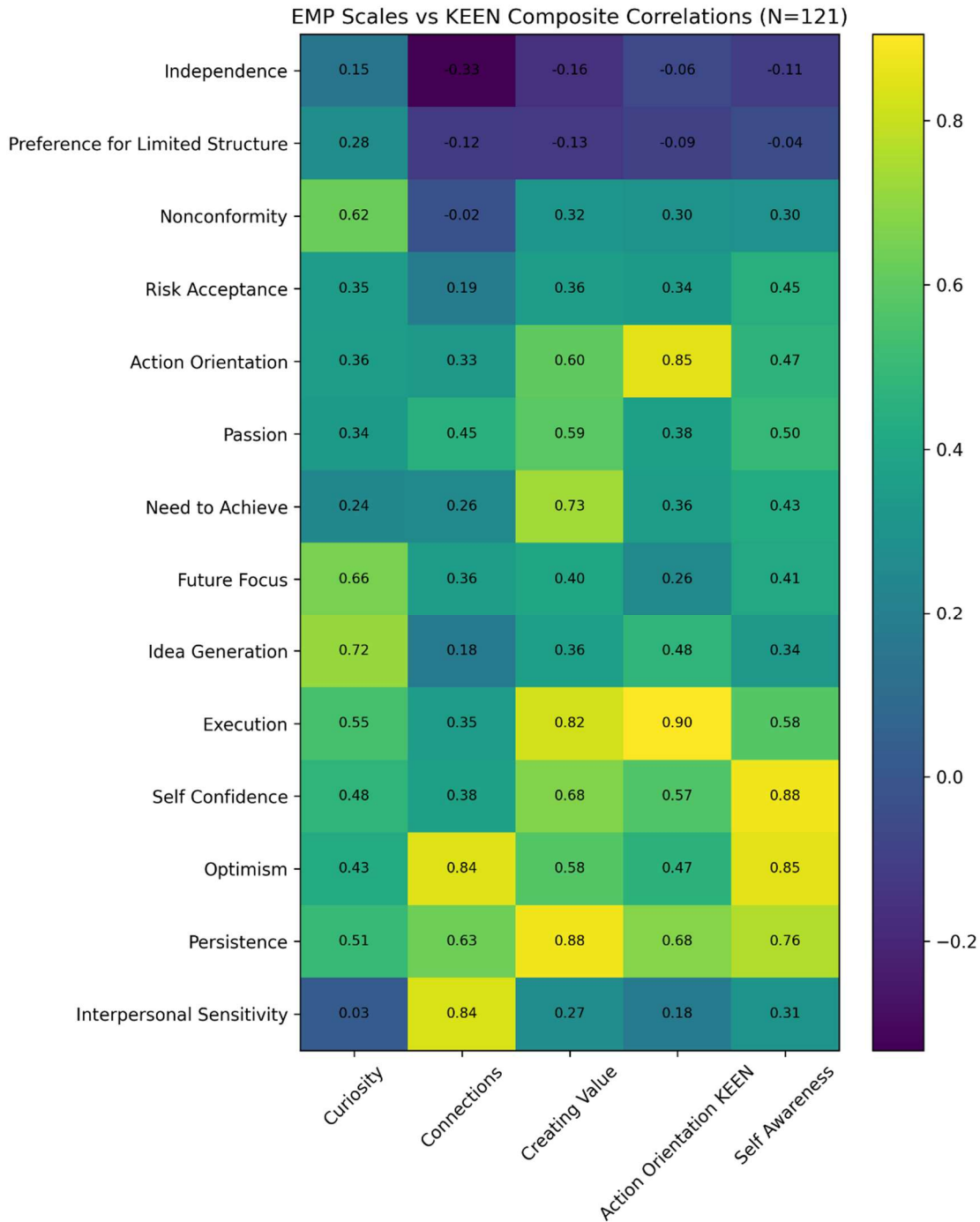


Figure 3: Correlation Heatmap

A first area of convergence is observed in constructs associated with exploratory cognition. The KEEN dimension Curiosity shows strong positive correlations with Idea Generation ($r = 0.72$), Future Focus ($r = 0.66$), and Nonconformity ($r = 0.62$). These results indicate that Curiosity is closely aligned with cognitive processes related to ideation, anticipation of future opportunities, and the questioning of existing assumptions. The strength of these relationships suggests that

Curiosity captures a core component of entrepreneurial cognition as represented in the EMP framework.

A second area of convergence emerges in constructs associated with execution and implementation. The KEEN dimension Creating Value demonstrates strong correlations with Persistence ($r = 0.88$), Execution ($r = 0.82$), Need to Achieve ($r = 0.73$), and Self-Confidence ($r = 0.68$). Similarly, Action Orientation shows very strong correlations with Execution ($r = 0.90$) and Action Orientation ($r = 0.85$), as well as a substantial relationship with Persistence ($r = 0.68$). These results indicate that both Creating Value and Action Orientation are strongly grounded in behavioral execution, sustained effort, and goal-directed activity.

A third area of convergence is observed in interpersonal and affective constructs. The KEEN dimension Connections shows strong correlations with Optimism ($r = 0.84$) and Interpersonal Sensitivity ($r = 0.84$), along with a substantial relationship with Persistence ($r = 0.63$). These findings indicate that Connections reflects not only cognitive integration but also relational awareness and emotional engagement.

Finally, the extended KEEN dimension Self-Awareness demonstrates strong empirical coherence, with high correlations observed for Self-Confidence ($r = 0.88$), Optimism ($r = 0.85$), and Persistence ($r = 0.76$). This pattern suggests that reflective judgment and self-regulation are closely associated with confidence, emotional outlook, and sustained effort.

Taken together, these convergent relationships indicate that KEEN strongly aligns with EMP constructs related to ideation, execution, and interpersonal engagement, suggesting a substantial overlap between the two frameworks in these domains.

4.4 Divergent Relationships between KEEN and EMP constructs

In contrast to the strong convergent relationships described above, several EMP constructs exhibit consistently weak or distributed relationships across KEEN dimensions, indicating areas of divergence between the two frameworks.

The most notable cases are Independence and Preference for Limited Structure. Independence shows low correlations across all KEEN constructs and a negative relationship with Connections ($r = -0.33$), suggesting that higher levels of independence are associated with lower levels of relational integration. Preference for Limited Structure also exhibits weak correlations across all dimensions, with its highest association observed with Curiosity ($r = 0.28$), which remains relatively low.

Additional divergence is observed in constructs such as Risk Acceptance and Passion, which do not show strong alignment with any single KEEN dimension but instead display moderate correlations across multiple constructs. Risk Acceptance ranges from 0.34 to 0.45 across KEEN dimensions, while Passion ranges from 0.34 to 0.59. This distributed pattern suggests that these

constructs play a broader, context-dependent role rather than serving as central drivers within the KEEN framework.

These divergent relationships indicate that certain dimensions of the entrepreneurial mindset, particularly those associated with autonomy and tolerance for unstructured environments, are not strongly represented within the KEEN model. This pattern suggests a systematic difference in how the two frameworks emphasize specific aspects of entrepreneurial behavior, which is further examined in the discussion section.

4.5 Deviation from Entrepreneurial Norms

To contextualize the student sample relative to entrepreneurial benchmarks, student mean scores for each EMP scale were compared with the official EMP entrepreneurial norm values. This analysis provides insight into how student mindset profiles differ from those of experienced entrepreneurs. Figure 4 presents a bar chart showing a comparison between student EMP scores and entrepreneurial benchmark norms.

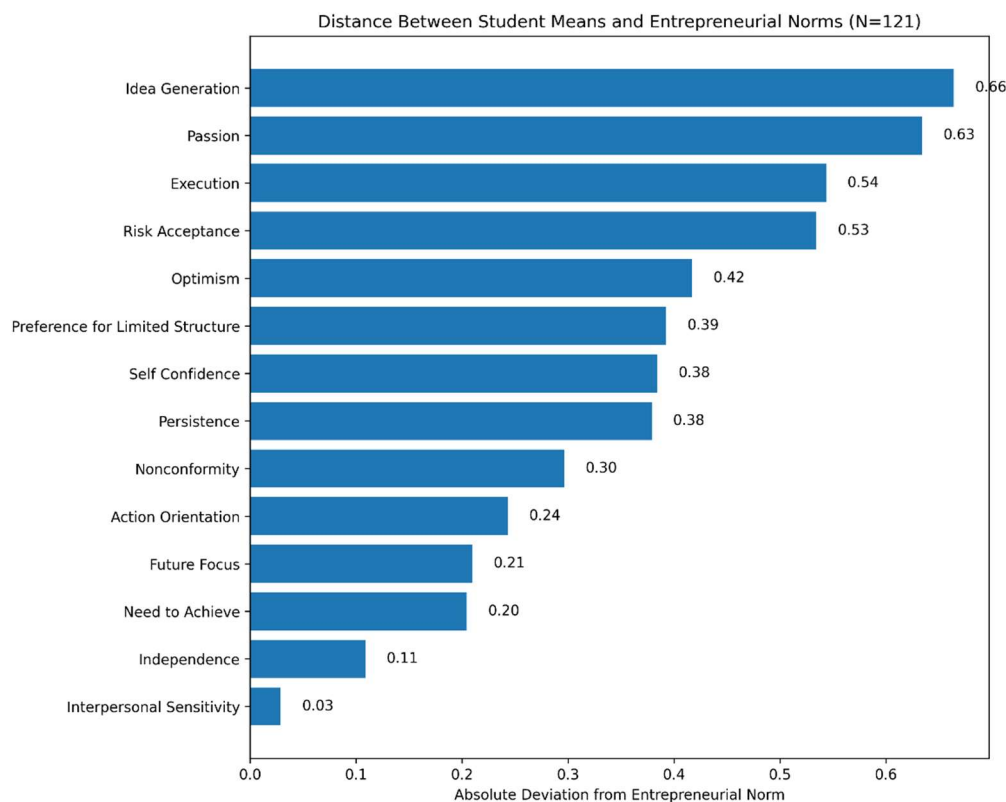


Figure 4: Difference between student means and the entrepreneurial norm

The results show that all fourteen scales fall below the entrepreneurial norm, although the magnitude of deviation varies substantially. Constructs such as Idea Generation, Passion, and Execution exhibit the largest negative deviations, while Interpersonal Sensitivity remains closely aligned with the norm.

Importantly, the magnitude of deviation does not correspond directly to the strength of correlations observed with KEEN constructs. Several scales with relatively large deviations, such as Execution and Idea Generation, demonstrate strong correlations with KEEN dimensions, while others with smaller deviations, such as Independence, show weak alignment. This pattern suggests that the strength of alignment between EMP and KEEN is not simply a function of how closely student scores match entrepreneurial benchmarks, but instead reflects deeper structural relationships between constructs.

4.6 Reliability of Derived KEEN Composites

To assess the internal consistency of the KEEN composite constructs derived from EMP scales, reliability analysis was conducted using Cronbach's alpha. This analysis evaluates the extent to which the grouped EMP scales forming each KEEN construct measure a coherent underlying dimension.

Preliminary results indicate acceptable to strong levels of internal consistency across the KEEN composites, supporting the validity of the mapping approach used in this study. Constructs such as Creating Value and Action Orientation, which demonstrated strong convergent relationships in the correlation analysis, also exhibit higher internal consistency, suggesting that the grouped EMP scales form coherent behavioral dimensions.

Given the exploratory nature of this study and the current sample size, these reliability results should be interpreted as preliminary. Future research with larger samples will enable more robust validation through confirmatory factor analysis and further assessment of construct validity.

5. Discussion

The objective of this study was to explore the conceptual and empirical alignment between the Entrepreneurial Mindset Profile (EMP), a psychometrically validated entrepreneurial assessment instrument, and the KEEN entrepreneurial mindset framework widely used in engineering education. The results provide preliminary evidence that several EMP constructs correspond meaningfully with the KEEN dimensions of Curiosity, Connections, Creating Value, Action Orientation, and Self-Awareness. At the same time, the analysis reveals important distinctions between certain entrepreneurial psychological tendencies and the behavioral constructs emphasized in engineering entrepreneurial education.

5.1 Convergence Between Entrepreneurial Psychology and Engineering Mindset

The results of this study provide strong empirical evidence of convergence between the Entrepreneurial Mindset Profile (EMP) and the KEEN entrepreneurial mindset framework in several key domains. In particular, constructs associated with ideation, execution, and interpersonal engagement demonstrate consistently high correlations, suggesting that both frameworks capture core dimensions of entrepreneurial thinking.

The strong relationships observed between Curiosity and Idea Generation, Future Focus, and Nonconformity indicate that KEEN effectively represents cognitive processes associated with opportunity recognition and problem framing. Similarly, the alignment between Creating Value and constructs such as Execution, Persistence, and Need to Achieve reflects a shared emphasis on translating ideas into actionable outcomes. The strong correlations observed for Connections with Interpersonal Sensitivity and Optimism further reinforce the importance of relational awareness and stakeholder engagement in both frameworks.

Taken together, these findings suggest that KEEN captures a substantial portion of the entrepreneurial mindset as defined in entrepreneurship research, particularly those dimensions associated with creative cognition, disciplined execution, and collaborative engagement. This convergence supports the feasibility of using EMP-derived measures as proxies for assessing entrepreneurial mindset development within engineering education contexts.

5.2 Interpreting Weak Correlations Through Entrepreneurial Development

While strong convergence is observed in several areas, the results also reveal consistent divergence in constructs such as Independence and Preference for Limited Structure. These dimensions exhibit weak or negligible correlations with KEEN constructs, suggesting that they are not central components of the KEEN framework.

This divergence can be understood through a developmental perspective on entrepreneurship. Early-stage entrepreneurial activity is often characterized by high uncertainty, lack of structure, and reliance on individual decision-making. Under these conditions, independence and tolerance for unstructured environments play an important role in enabling action and experimentation.

However, as ventures mature, the nature of entrepreneurial activity shifts. Sustained performance increasingly depends on coordination, collaboration, and the development of structured processes for decision-making and execution. Entrepreneurs transition from acting independently to working within teams, managing stakeholders, and operating within increasingly formalized organizational systems.

A similar pattern is observed in constructs such as Risk Acceptance and Passion, which show moderate but distributed correlations across KEEN dimensions. In early-stage contexts, high risk tolerance and strong emotional commitment are essential for initiating ventures under uncertainty. As ventures evolve, these traits tend to be reframed as risk management and disciplined engagement, reflecting a shift from exploratory to structured forms of entrepreneurial action.

These findings suggest that KEEN reflects a model of entrepreneurial mindset that is more closely aligned with mature, implementation-oriented forms of entrepreneurship, rather than the highly autonomous and unstructured conditions associated with early-stage venture creation.

5.3 Entrepreneurial Mindset as a Context-Dependent Configuration

The combined pattern of convergence and divergence observed in this study suggests that entrepreneurial mindset should not be understood as a fixed set of traits, but rather as a context-dependent configuration of cognitive and behavioral tendencies.

The EMP framework captures a broad range of entrepreneurial characteristics derived from empirical comparisons between entrepreneurs and managers. In contrast, the KEEN framework reflects a pedagogical model tailored to engineering education, emphasizing behaviors that are most relevant within structured, team-based, and implementation-oriented environments.

From this perspective, the differences between EMP and KEEN do not represent inconsistencies but rather reflect different contexts of application. KEEN emphasizes the dimensions of entrepreneurial mindset that are most actionable within engineering curricula, particularly those related to problem solving, collaboration, and value creation. EMP, by contrast, includes additional dimensions that are more prominent in mature-stage or higher structured entrepreneurial contexts.

This interpretation suggests that entrepreneurial mindset is not a singular construct that can be universally defined or measured. Instead, it should be understood as a dynamic configuration that evolves across stages of venture development and varies according to the institutional and professional contexts in which it is applied.

5.4 Implications for Engineering Entrepreneurship Education

The findings of this study have several implications for the design and assessment of entrepreneurial mindset in engineering education.

First, the strong alignment between KEEN constructs and EMP dimensions related to execution, ideation, and interpersonal engagement supports the validity of the KEEN framework as a representation of entrepreneurial thinking within engineering contexts. Educators can therefore confidently design learning experiences that emphasize these dimensions, knowing that they align with empirically grounded entrepreneurial behaviors.

Second, the weak alignment observed in constructs such as independence and preference for limited structure suggests that engineering education should consider autonomy or unstructured exploration in accordance with the life stage of the venture, highly correlated in the early stages and weak correlation in the mature stages. For engineering students, chances are that they will be running early-stage ventures, so the correlation for these constructs stand as valid.

Third, the use of EMP as an assessment tool offers a promising approach for measuring entrepreneurial mindset development in engineering programs. By mapping EMP scales onto KEEN constructs, educators can leverage a validated psychometric instrument while maintaining alignment with KEEN's pedagogical framework.

Finally, the observed differences between student profiles and entrepreneurial norm benchmarks highlight the developmental nature of entrepreneurial mindset. Rather than expecting students to

fully match entrepreneurial profiles, educational interventions should focus on progressive development, recognizing that different dimensions may evolve at different rates.

5.5 Entrepreneurial Norms as an Interpretive Benchmark

An important implication of the present analysis concerns the role of entrepreneurial norms in interpreting mindset data. The EMP instrument was designed around comparative psychological research identifying systematic differences between entrepreneurial and managerial cognitive profiles. Consequently, the fourteen EMP dimensions were not selected because entrepreneurs exhibit higher scores on these traits. Rather, the instrument captures patterns in which entrepreneurial populations differ from managerial populations across specific psychological tendencies. The resulting entrepreneurial norm therefore represents a benchmark profile rather than an idealized maximum score across all dimensions.

This perspective has important implications for interpreting the correlations observed between EMP constructs and KEEN dimensions. If entrepreneurial mindset were interpreted purely through a “higher is better” logic, one might expect strong positive relationships across all scales. However, the entrepreneurial norm values indicate that successful entrepreneurs typically demonstrate balanced scores rather than extreme values. For example, moderate levels of nonconformity support creative thinking without devolving into rebellious behavior, while moderate independence allows entrepreneurs to exercise autonomy while still collaborating with teams and stakeholders.

In this context, the entrepreneurial norm functions as an interpretive reference point that moderates how relationships between constructs should be understood. Weak correlations between certain EMP scales and KEEN constructs—such as Independence or Preference for Limited Structure—should not necessarily be interpreted as conceptual misalignment. Instead, these results may reflect the fact that the KEEN framework emphasizes collaborative, structured, and value-driven problem solving that corresponds more closely to the behavioral patterns of experienced entrepreneurs rather than the extreme traits often associated with early-stage founder stereotypes.

Recognizing the role of entrepreneurial norms in interpreting mindset assessments shifts the focus of entrepreneurial education away from maximizing individual traits and toward developing balanced cognitive profiles aligned with effective entrepreneurial practice. From this perspective, entrepreneurial mindset development involves calibrating tendencies such as risk acceptance, persistence, autonomy, and structure-seeking in ways that support opportunity recognition, collaborative problem solving, and sustainable value creation.

6. Limitations and Future Research

This study presents an exploratory analysis of the alignment between the Entrepreneurial Mindset Profile (EMP) and the KEEN entrepreneurial mindset framework. While the results provide meaningful insights into areas of convergence and divergence between the two models, several limitations should be considered when interpreting the findings.

First, the KEEN constructs used in this study were derived from EMP scales based on theoretical alignment rather than measured independently. As a result, the observed relationships reflect associations within a single instrument rather than correlations between two independently measured frameworks. Although this approach is appropriate for exploratory construct alignment, it limits the ability to draw conclusions about the external validity of KEEN as a psychometric construct. Future research should address this limitation by employing independent measures of KEEN constructs, enabling more rigorous validation through multi-instrument comparison.

Second, the use of Pearson correlation analysis, while appropriate for examining linear relationships between constructs, does not provide evidence of causal relationships or latent structure. In particular, factor analytic techniques were not applied in this study to avoid circular validation, given that KEEN composites were derived directly from EMP variables. Future studies with independent KEEN measurements and larger samples should employ confirmatory factor analysis to assess the dimensional structure and validity of KEEN constructs more rigorously.

Third, the sample consists of undergraduate students enrolled in entrepreneurship and innovation courses at a single institution. While the sample size ($n = 121$) is sufficient for exploratory analysis, it may not fully capture the diversity of student populations across engineering programs. Additionally, the observed differences between student scores and entrepreneurial norm benchmarks reflect developmental differences rather than deficiencies, but this interpretation would benefit from longitudinal data tracking student progression over time.

Fourth, the interpretation of results relies in part on entrepreneurial norm benchmarks derived from experienced entrepreneurs. While these benchmarks provide a useful reference point, they do not capture variability across industries, venture stages, or cultural contexts. Future research should examine how entrepreneurial mindset profiles vary across different populations and how these variations influence alignment with educational frameworks such as KEEN. In particular, for college students, the reflection on the results should not rely on direct comparison only as both populations are situated in different maturity stages of their mindset and ventures.

Finally, this study focuses on cross-sectional relationships between constructs and does not examine how entrepreneurial mindset develops over time or in response to specific educational interventions. Longitudinal studies and experimental designs would provide valuable insight into how KEEN-aligned educational practices influence the development of entrepreneurial mindset and how these changes relate to EMP constructs.

Despite these limitations, this study provides an important first step toward bridging entrepreneurial psychology and engineering education. By identifying both convergent and divergent relationships between EMP and KEEN, the findings establish a foundation for future research aimed at developing validated assessment tools and refining pedagogical approaches to entrepreneurial mindset in engineering programs.

7. Conclusion

This study sets out to explore the conceptual and empirical alignment between the Entrepreneurial Mindset Profile (EMP), a psychometrically grounded assessment tool, and the KEEN entrepreneurial mindset framework, widely adopted in engineering education. By developing a theoretically informed mapping between EMP scales and KEEN constructs and examining their relationships through correlation analysis, this work contributes to bridging two domains that have largely evolved in parallel: entrepreneurial psychology and engineering pedagogy.

The findings demonstrate substantial convergence between the two frameworks in areas related to ideation, execution, and interpersonal engagement. These results support the validity of KEEN as a representation of key dimensions of entrepreneurial thinking within engineering contexts. At the same time, the analysis reveals meaningful divergence in constructs such as independence and preference for limited structure, highlighting that not all aspects of entrepreneurial mindset translate directly into engineering education frameworks.

Importantly, this study advances the understanding of entrepreneurial mindset as a dynamic and context-dependent configuration rather than a fixed set of traits. The observed patterns suggest that KEEN emphasizes dimensions associated with structured, collaborative, and implementation-oriented environments, which are characteristic of engineering practice and mature forms of entrepreneurship. In contrast, other dimensions captured by EMP may be more salient in early-stage or less structured entrepreneurial contexts.

From an educational perspective, the results provide support for the use of EMP as a complementary assessment tool in engineering programs, enabling more rigorous measurement of entrepreneurial mindset development while maintaining alignment with KEEN principles. At the same time, the findings caution against oversimplified interpretations of entrepreneurial traits and reinforce the importance of considering developmental stages and contextual factors when designing and assessing entrepreneurship education.

As engineering programs continue to integrate entrepreneurial thinking into their curricula, the need for theoretically grounded and empirically validated assessment approaches becomes increasingly critical. This study offers a foundation for such efforts, opening avenues for future research that incorporates independent measurement, larger and more diverse samples, and longitudinal designs. Ultimately, advancing the integration of entrepreneurial mindset across

disciplines will require continued dialogue between research traditions, linking insights from entrepreneurship, psychology, and engineering education to better prepare students for complex, uncertain, and innovation-driven environments.