



## Creating a Master "Entrepreneurial Mindset" Concept Map

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## Creating a Master “Entrepreneurial Mindset” Concept Map

The knowledge, skills, and attitudes associated with an entrepreneurial mindset (EM) continue to be debated within the entrepreneurship field. Although overlapping in their properties, there exist several definitions of what comprises an EM within engineering. For instance, as summarized in a recent review by Zappe [1], EM can range from a problem-solving approach applied within one’s life, to the associated skills and behaviors such as opportunity recognition, creativity, and risk mitigation that may be developed within individuals. Due to this range of definitions, it can be difficult to assess whether the EM is being developed within engineering students.

One method for assessment that could address this lack of an exact definition is concept maps. Concept maps are used to assess the knowledge and understanding of a specific topic area. The graphical representation of the concept map, through nodes and links, captures a broader perspective and comprehensive knowledge of the centralized idea by the participant. In this work, we explore the development of a master concept map as a tool that can be used when assessing students’ understanding of the EM. The master concept map was developed through the review of 26 concept maps on the subject “Entrepreneurial Mindset” prepared by faculty members at institutions across the United States with expertise in the engineering entrepreneurship field. We followed a systematic investigation process to go through each concept map identifying concepts across all of the maps, and counting the frequency of each concept’s occurrence. Preparation of this concept list from the experts’ concept map was considered as a holistic list of all the concepts pertaining to the EM, although not necessarily comprehensive. Afterward, we developed overarching themes that described the concepts present and then mapped them according to proposed linkages provided within the experts’ maps thus generating a master concept map for “Entrepreneurial Mindset”. Upon completion of the master concept map, we reviewed it against the different frameworks available in the literature to determine hierarchies in need of expansion, connection or further refinement. This master concept map on EM represents a first step in the development of an assessment approach that can assist with direct assessment of students’ EM development.

### Introduction

Entrepreneurship (or intrapreneurship) has become an important aspect to integrate within the engineering curriculum due to its focus on the development of collaborative skills, technical and analytical skills, flexibility, resiliency, creativity, empathy and the ability to recognize and seize opportunities [2], [3]. Over the past decade, engineering educators and scholars have focused attention on dispositions and behaviors that characterize an engineering “mindset” [4], thereby broadening engineering preparation beyond knowledge and skills. The next generation of entrepreneurial-minded engineers will be expected to demonstrate traditional technical expertise of an engineer as well as organizational level leadership to meet the needs of changing markets [5]. These types of engineering entrepreneurial skills have been shown to be teachable, yet assessment and evaluation of engineering entrepreneurial learning is an underdeveloped field of research [6]. In a literature review by Zappe [1], the definition of the term “entrepreneurial mindset” varied substantially. For instance, Worcester Polytechnic Institute stated EM was an approach to solve problems and way of life but others mentioned it can also be comprised of characteristics such as opportunity recognition and ability to actualize ideas. These results demonstrate that an agreed upon definition for EM has yet to be reached [1].

For this reason, assessment and measurement of entrepreneurial mindset (EM) can be very difficult due to the variety of complex constructs and sub-constructs that are involved [1]. Concept maps are one assessment method that could be useful to the engineering entrepreneurship field by accounting for the complexities associated with the EM definition. Concept maps are a widely accepted tool for formative assessment and are visual representations of a person's networked knowledge about a particular topic [7]. The complexity of a concept map directly represents the knowledge depth and breadth of the individual, where its organization shows the individual's understanding of the knowledge domain and interconnected relationships. Thus, concept maps are one tool that instructors may use to evaluate students' integrated knowledge and understanding [8], [9].

To assist in providing an assessment tool for faculty to measure EM, we have curated an expert "Entrepreneurial Mindset Concept Map" that may be used as a tool to assess targeted attributes of knowledge, skills, and attitudes pertaining to EM. This form of assessment instrument will provide the capacity to measure and differentiate level of competencies through formative assessment as outlined in literature [5]. The expert concept map was generated through review of 26 engineering entrepreneurship faculty members' personalized views of EM depicted in their own concept maps. Review of these maps led to identification of key themes relevant to EM that were then reviewed against frameworks available in the literature to identify any missing elements. This master EM concept map is the first step towards the development of a direct assessment tool that can be used to measure students' learning and development of EM.

## **Background**

The 21<sup>st</sup> century has seen a wealth of information and technological advances that demonstrate a need for development of innovation and problem solving skills among engineering graduates [2]. One method through which this can be developed is the integration of activities that assist with EM development. EM, a term yet to be well-defined, broadly includes skills traditionally linked to business development like creativity, opportunity identification, risk taking, and professional attributes like problem solving, planning, innovation, and decision making [5]. Entrepreneurial-minded engineers are multi-talented, responsive to market changes, exhibit the qualities of a traditional engineer, and serve as leaders [5]. Indeed, there are individuals within the engineering education community who suggest that educators should develop an EM among all engineering undergraduate students regardless of their choice to start a new business [2], [6], [10] due to opportunities for employees to innovate within existing organizations as intrapreneurs. It is also noted that there is a need for more work focused upon the development of teaching strategies and assessment of learning outcomes within the engineering entrepreneurship field. [11], [12].

Duval-Couetil et al. noted that engineering entrepreneurship is a new, ongoing research field that is still lacking in generalized assessment instruments for the knowledge, skills, and attitudes pertaining to EM [13]. Engineering educators have been observed to apply assessment tools from management courses although these instruments are lacking engineering focused EM attributes [6], [9]. Literature pertaining to EM also points out the importance of an assessment instrument that can handle the complexity of this term, which leads us to the suggestion of use of an expert generated concept map as an assessment tool that can provide a graphical representation of student knowledge [1], [14], [15]

### *Use of Concept Maps in Engineering Education*

Concept maps are a graphical representation of a central topic through the use of nodes and links, which represent concepts and their relationships. Creating a concept map is a meta-cognitive activity, which facilitates conveyance of understanding, and information retained and can be a quick approach to assessment [7], [8]. Concept maps have been widely used in engineering education, but specifically have been used for three purposes: formative assessment of student learning in courses and programs [16], design of course plans [17], and as an expert generated map to disseminate knowledge [15]. Each of these strategies will be discussed in more detail in the paragraphs to follow.

Generally, concept maps are considered as a formative assessment strategy, since they provide a heuristic tool that demonstrates student knowledge of a subject either before or after instruction on a topic [7]. Instructors can use concept maps to evaluate the trends and gaps in student's knowledge compared to course learning objectives and determine the progression of the students' learning from the beginning to the end of the course [3], [11]. Akinsanya and Williams have shown how assessment with concept maps can help to consolidate prior knowledge and can provide an opportunity to gain new structure of knowledge within a shorter period of time [18]. Review of the concept maps generated by students can also help identify students' weaknesses and strengths in domain knowledge [16]. Instructors can assess students at earlier time points in a course, to identify potential areas of weakness that can be addressed throughout the remainder of the instruction. In order to assess student learning, either formatively or summatively, an instructor needs to select an appropriate scoring method(s) for the concept maps. Several quantitative and qualitative scoring methods have been developed and applied to engineering students' concept maps, with each taking a different approach to capturing a map's complexity. Concept map scoring methods typically include measures of conceptual depth, breadth, and connectedness [19].

A concept map can be used before the start of a course to assist with course design and instructional strategy planning [17]. The two dimensional nature of the concept map helps to conceptualize outlines and break the course content down into sequential units that represents a cohesive model to understand the instructional course unit [7], [20]. It can also provide an opportunity for instructors to easily visualize content areas identifying ones that are of less importance and thus perhaps should be removed from the course, alongside major themes that may require additional emphasis [21]. In these cases, the concept map can help provide students with an overview of the desired knowledge outcomes for a specific subject area and a quick understanding of the course content with its structure. The pictorial visualization of the concept map makes it easy to interpret quickly, shows dependencies, and connectedness of the course content. It can provide a means to track progress over the course of a semester.

Novak has discussed the application of expert generated concept maps, as capturing the knowledge of experts in an explicit, concise form for future use. They have demonstrated the use of expert concept maps as a means to capture and preserve the tacit knowledge of experts, to share it and clarify complex ideas into meaningful learning [15]. An expert generated concept map can also be used as a curriculum-planning tool or for course wide presentations [22]. Expert generated concept maps can serve as advanced organizers to show the relationship between important ideas within lesson planning [23]. They can also demonstrate the relationships between new knowledge and prior knowledge [24]-[25] and be used to assess student learning of new concepts [23], [26].

Concept maps demonstrate a promising approach to assess the attributes of EM. As such, this paper provides the development of an expert concept map on EM, which can be used by faculty members to assist with evaluating the EM of engineering students. Through the review of the master concept map, faculty members will be able to identify the key categories that should be present within student maps and upon review of the comprehensive concept list can match terms that are used by students with the EM element they represent thereby providing a fair assessment of students' understanding of this complex construct. Additionally, the expert map can be used formatively as a guide to help students identify gaps in their own understanding or skill development and then develop a roadmap for how to continue developing their EM.

## **Methodology**

This study involved 26 faculty members with expertise in engineering education and entrepreneurship that participated in a workshop as part of the KEEN National Conference in January 2019. The participant faculty members had varying degrees of familiarity with the EM framework. As part of the workshop, faculty members were trained in how to generate concept maps through instruction about their design and use within engineering education. [27]. After the training, faculty members developed a concept map on the central theme of EM. Proper human subjects' approval was obtained prior to collection of the concept maps for use in this study.

### *Creation of Master Concept Map*

To create the master concept map, we performed a systematic review of all the faculty concept maps, identifying, and listing all 383 concepts found in the maps. We then counted the frequency of occurrence of each concept. After this list was generated, two researchers generated a thematic list for the master concept map by following seven steps described below and modeled after thematic text analysis processes [28]. To ensure individual biases did not influence the development of the expert EM concept map, one of the authors did not refer to any literature on EM before reviewing the concept maps prepared by experts and generating the list of themes. To minimize the impact of researcher biases, the two researchers worked independently through steps 0 – 2, and then went through a consensus process (step 3). A third researcher did additional literature review to inform the later phase of the development process in step 4. In the remaining steps, 4-6, the three researchers continued to go through a consensus process to advance the content and organization of the EM master map. Details on each step are provided in the following sections.

#### **Step 0: Proofreading and rectification (Error removal Process)**

A researcher proofread the generated concept list to fix any obvious written spelling errors. Next, concepts that were different but had similar meanings were combined as they represented duplication of a concept. As an example, two concepts on the list included “solve big problem” and “solve small problem” however, they both fell under the concept “solve problems”. Hence, the “solve problems” concept was retained and the other two concepts were combined under this heading. A few concepts had the “/” sign, included. For analysis purposes, these two terms were separated and listed independently within the list. Additionally, concepts were merged that were found to share the same meaning. For instance, “value creating” and “value creation” were considered identical with the concept “creating value”; hence, both of the former terms were not used in the final list. Concepts that were similar in nature but had different meanings were retained as separate, such as “Starting a company/ initiatives” which was considered different from the concept “startups”. After removing errors and eliminating duplicative terms, 303 concepts remained.

Step 1: Code generation process

After preparing an error free list of all the concepts, two researchers (also authors of this paper) reviewed each concept and clustered the concepts into subgroups as appropriate. A subgroup is a list of the concepts that are closely related and fall under a common theme or area. Table 1 shows examples of a few themes and the concepts that fall within their subgroup.

Table 1. Examples of Subgroup Generation

<i>Theme</i>	<i>Skills</i>	<i>Connections</i>	<i>Technology</i>	<i>Collaboration</i>
<b>Concepts</b>	-Additional skill set/ Professional skill -Engineering skill -Great communication skills -Interpersonal skill -Lifelong learning -Technical skills -Better engineers -Out of the box thinking -Employer request 21st century workforce / job readiness / preparedness	-Connected -Develop connections -Creating connections -Background -Building a platform - Networking/meet	-To offer applications -Patents	-Cooperation -Partnership to problem solve -Adapt -Cognitive biases -Open to constructive feedback

Steps 2 and 3: Creating Categories and Reaching Consensus

After generating a list of subgroups, the second author reviewed them to check any overlapping of the concepts or subgroups. Each group was given a category name depicting the overall theme of that subgroup or subgroups. A categorical name might be within that subgroup/subgroups or might be a new word or phrase representing the overarching theme of the subgroup(s). Next, the third author reviewed all subgroups and categories and noted alternative ways to cluster or name categories. The two researchers met virtually to discuss differences and make iterative adjustments, ultimately reaching agreement on the subgroups and categories. Table 2 shows the process of consensus and clustering to define the categories.

Table 2. Category creation and consensus

<b>Author 2</b>	<b>Author 3</b>	<b>Consensus</b>
<i>Attitude</i> under action category	<i>Attitude</i> under entrepreneur category	<i>Attitude</i> is a separate category having the following concepts: Adventure outlook, curiosity/how things work, experience, lesson learned, positive outlook, perspective <i>*Entrepreneurs often possess or develop these attitudes.</i>

This discussion led to identification and clustering of all the concepts under 24 unique categories that define EM.

#### Step 4: Knowledge Gap Identification

As noted in the work by Zappe, educators can be influenced by their own career experience and belief about entrepreneurship when seeking to define EM [11]. The researchers who conducted the previous steps represent different disciplinary and career backgrounds. A third researcher, with a different disciplinary background, reviewed existing literature that described EM and identified gaps in the categories and concept lists. These new concepts were placed under a relevant category from Step 3. The first two columns in Table 3 show the concepts considered “behaviors” after consensus (column 1) and new concepts that were identified after this gap analysis process (column 2).

Table 3. Knowledge gap and Final consensus process

Concepts Before Literature Review ( <i>Behavior</i> )	Concepts added from Literature ( <i>Behavior</i> )	Concepts After Consensus ( <i>Behavior</i> )
Action, Adapt, assess, dream, listening, implement ideas, observe, out of the box thinking, overcoming barriers, persistence, resilience, question, reflection, research, self-authorship, breakdown barriers, intentions	Help Seeking, Resourcefulness, Autonomy, Critical thinking, Manage Risk, Serving others, Achievement	Resourcefulness, Critical thinking, cognitive adaptability, assess, dream, listening, implement ideas, observe, out of the box thinking, overcoming barriers, persistence, resilience / tenacity, question, research, Reflection, self-authorship, breakdown-barriers, intentions

#### Step 5: Adjustment and Final Category List

All three authors met and discussed each of the categories and concept distributions and made iterative changes until consensus was reached. In total, we identified 237 distinct concepts in 24 categories that help describe EM, including those identified from the literature. The last column in Table 3 gives an example of the final consensus list of attributes under the Behavior category.

#### Step 6: Generation of Working EM Master Concept Map for EM

After Step 5, we used the Cmap tool (<https://cmap.ihmc.us>) to create the working EM master concept map. In an effort to create a map that would be useful to faculty in providing a solid overview of EM without going into a level of detail that could be considered overwhelming, only the 24 category names were initially used in the generation of the map. The map was generated based on the researchers’ understanding of the relationship between categories; however, no cross-links were included to avoid the researchers’ biases influencing the relationships that were noted on the map between categories. When it was evident that there were key elements missing that appropriately described the categories listed on the working EM concept map, the researchers would identify if concepts listed under these categories should be added to the Working EM Master Concept Map. In all, seven additional terms

were added to the Working EM Master Concept Map resulting in a map with 31 categories present.

#### Step 7: Review of Working EM Master Concept Map by Faculty Experts

As a last step in the master concept map generation process, the map developed in Step 6 was provided to seven faculty with expertise on EM. These faculty members were provided with the working version of the master concept map as well as the list of concepts in table format that were associated with the categories present within the map. The goal of this faculty expert review was to determine if the organizational structure of the working EM master concept map made sense and if not, what changes were suggested to be made. The faculty experts also provided feedback on both the categories and concepts found under each of the categories to identify potential missing categories or concepts that would be pertinent to the master EM concept map. Finally, the faculty experts also weighed in on what cross-links should exist between the categories present on the working EM master concept map.

After collection of the feedback from the faculty experts, the researchers on the project met and discussed how the feedback could be incorporated into the working master EM concept map to obtain a finalized master EM concept map. Changes that were made as part of this portion of the process are discussed within the Results and Discussion section of the paper.

### **Results and Discussion**

The goal of generating an EM concept map from expert faculty was to provide a single concept map that captures a high-level overview of the categories associated with the complex construct of EM. This section of the paper will be subdivided into two sections. The first section will provide an overview of the working EM master concept map that was created while the second section will include the finalized EM master concept map prepared after further review of the working map by faculty experts. Each section will describe the organizational approach to the EM master concept map and the decisions that were made to ensure the best approach to visualization for faculty members.

#### *Working EM Master Concept Map*

The working EM Master Concept Map included a total of 31 categories that covered diverse aspects of an EM as shown in Figure 1.

One way to describe the working EM master concept map is to think about the different facets of EM it captures. For instance, the working EM master concept map describes “who” may hold an EM through its higher-level branch entitled “entrepreneur/intrapreneur”. Within this branch there are categories that describe where an entrepreneur/intrapreneur may work, what types of attributes they may have (shown under personal attributes), the skills they may need to use, such as communication and collaboration, and how they enact their use of EM (shown under the process category). The working EM master concept map also captures “what” may be involved within having an EM as illustrated with the category branch beginning with “knowledge & skills”. This branch includes elements that as faculty we would think are necessary to develop in our students as we seek for them to build an EM. Examples of the concepts that fell under these higher-level categories include fields of study such as engineering, marketing, science, and liberal arts, as well as broader career preparation skills, which include leadership, creativity, professional skills, and having a global view with intercultural awareness.



Another aspect of EM observed in Figure 1, is “why” an EM may be useful as captured in the “creating value” category branch. Within this branch, categories focused on the outcome or goals associated with enacting an EM are found including society, sustainability, meet needs, and value propositions. The final key area that the working EM master concept map captures quite well is “how” an EM may be developed in students. The answer to this question is found under the branch that starts with “formal education” and includes categories such as pedagogy and education system.

The concepts that fell underneath the themes within the map varied in nature, as shown by some of the examples already discussed, but could be quite extensive. For instance, Table 4 shows all the concepts that were found to be associated with the thematic branch labeled as personal attributes.

Table 4. Concepts contained within the Personal Attributes Thematic Branch

Personal Attributes		
Attitudes	Behaviors	Character/Personal Traits
Adventure outlook	action	charisma
Curiosity/how things work (inquisitiveness/interest)	cognitive adaptability	courage
experience	assess	identity
lesson learned	dream	ethics
positive outlook / optimism	listening	humility
perspective	implement ideas	initiative / agency / autonomy
	observe	Motivation / Passion
	out of box thinking	Open Mindedness
	overcoming barrier	personal
	persistence	responsible
	resilience / tenacity	social sensitivity
	question	sense of play
	research	strengths
	Reflection	Altruism
	self authorship	Empathy
	breakdown barriers	Comfort with risk
	intentions	Risk propensity / risk taker
	Resourcefulness (broader than just physical resources)	Tolerance for ambiguity / uncertainty
	Critical thinking	team orientation
		intuition
		Integrity

The concepts shown in black within the table were those identified from the faculty concept maps themselves, whereas the concepts shown in blue were additional concepts identified through the literature review performed. As can be observed from Table 4, concepts associated with personal attributes of an EM vary considerably and encompass specific behaviors such as reflection and out of the box thinking to more personal traits such as empathy, comfort with risk, and motivation/passion towards the area of focus.

*Final EM Master Concept Map*

Upon review of the working EM master concept map with faculty experts, it was observed that changes could be made to the organizational structure of the map to provide a better picture of EM that could be visualized with a quick look at the map. Feedback was also provided, as

discussed in the Methods, about categories that appeared to be missing from the working EM master concept map and what cross-links should be present between the different branches that were included in the map. The finalized version of the concept map after incorporation of this feedback is shown in Figure 2 and presented in a hierarchical table in Appendix A.

The finalized EM master concept map now provides a clearer picture of answers to the questions “who”, “what”, “why”, and “how”. The reviewers did not identify significant gaps, indicating that the working EM master concept map was comprehensive, but they elevated certain concepts to higher levels of a hierarchy or combined concepts into new hierarchies. For instance, the faculty experts suggested that the “what” branch be modified to include “knowledge, skills, & attributes” rather than just “knowledge & skills”. This suggested change led to moving the personal attributes category branch from under the “entrepreneur/intrapreneur” branch over to the “knowledge & skills” branch thereby providing a more comprehensive definition of the traits we would associate with the development of an EM. This branch now incorporates concepts expanding beyond the disciplines and the career preparation skills mentioned earlier to include behaviors such as listening, observing, persisting, breaking down barriers, and reflecting among others, as well as character/personal traits including courage, humility, open mindedness, social sensitivity, empathy, and comfort with risk (detailed list of concepts can be referenced in Table 4).

Another significant change that was made to the map was in the branch comprising “how” an EM was being developed. The faculty experts acknowledged that formal education is one way in which an EM may be developed but they shared that EM development extends beyond this to include both experiences individuals may have whether they are personal or not and “extra and co-curricular experiences” such as participation in clubs and co-ops / internships as part of students’ degree program.

A minor change that was made to the working EM master concept map in this round of faculty review was the move of “intellectual property/technology” to fall under the category branch of “modification” and “innovation”. Although the faculty experts agreed that understanding intellectual property is important to an EM, they did not feel that, this knowledge would exist as a skill in and of itself but rather would be central to the work done to create and/or modify a product.

As mentioned, cross-links were also added to the working EM master concept map at this stage in order to illustrate connections across hierarchies. Key cross-links included the linkage of the “who” branch comprising of “entrepreneur/intrapreneur” with the “why” branch of “creating value”. This cross-link was meant to represent the motivation that an individual with an EM may have for pursuing to create and/or modify a product. A cross-link was also added that connected both the “why” (creating value) and the “what” (knowledge, skills, & attributes) branches with the branch that described the production of either a modification or an innovation. These cross links were included to demonstrate that both motivation, as shown in the “why” branch, and an EM, as defined in the “what” branch, are necessary to be able to move forward with producing a modification to an existing product or the creation of a new product, process, or system.

Other key cross-links included the relationship between the category of “teams” and the category of “knowledge, skills, & attributes”. Inclusion of this cross-link illustrates how an entrepreneur/intrapreneur cannot operate in a silo but rather must construct a team around them that provides them with individuals that have complementary knowledge, skills, & attributes

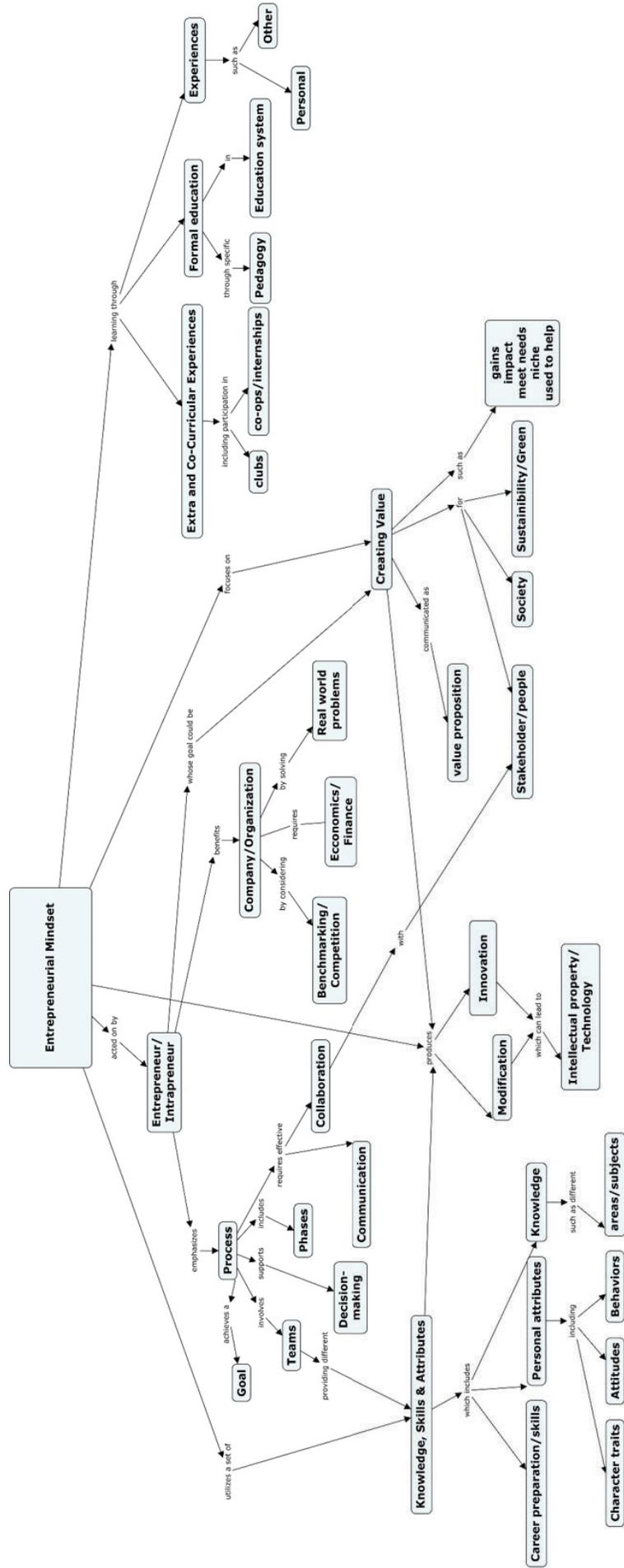


Figure 2. Finalized EM Master Concept Map

that they themselves may be lacking. A final cross-link was included between the category of “collaboration” and the category of “stakeholder/people”. Faculty experts felt that this cross-link was important to illustrate the relationship between product development and stakeholders with a focus on a continual discussion that occurs between these invested parties throughout the development/modification cycle.

#### *Limitations*

Although the finalized EM master concept map included within this paper will provide a great starting point for individuals to have a visualization of what is meant by the construct of EM, this study was not without its limitations. The initial faculty members that participated in the development of concept maps for the generation of the EM master concept map were individuals that attended the KEEN National Conference and had varying degrees of familiarity with EM. Based upon this variation, it is possible that there are elements of EM that did not end up being captured in the finalized EM master concept map that could have been obtained if the exercise was repeated with a different group of faculty experts in EM. The literature review gap analysis and additional round of faculty review of the working concept map helped to mitigate this limitation.

Another limitation is the focus of the EM master concept map. Using faculty in the development of the finalized EM master concept map led to a concept map with a focus on an educational lens towards the development of EM. If this study were to be repeated with entrepreneurs/intrapreneurs it is quite possible that the EM master concept map may be different in scope and organization. Finally, it is important to acknowledge that since this finalized EM master concept map represents faculty views of EM it is likely to incorporate a lot more depth and breadth than students going through their undergraduate programs may be able to generate. As such, we encourage faculty members to use the finalized EM master concept map as a guide in their evaluation of their students’ EM concept maps without necessitating inclusion of all categories and their associated concepts on the part of their students.

#### *Future Work and Potential Applications*

The finalized EM master concept map has a variety of potential applications for which it can be used. One application could be as a tool for determining how to assess students’ EM concept maps. Prior work done by Bodnar and Hixson [14] and Martine et al. [29] have attempted to assess students’ development of an EM with concept maps. However, when applying the holistic scoring approach, as described in Besterfield-Sacre et al. [30], it was necessary to make judgements on what concepts should be present within a students’ EM concept map. At the time, the two researchers involved in the study who had EM research experience compiled a listing based on their understanding of the literature with the acknowledgement that it was not a comprehensive representation of the field. Future work could involve repeating the analysis of these students’ EM concept maps using the new finalized EM master concept map as a guide for determining what categories should be present within a students’ EM concept map.

Another way that faculty could apply the EM master concept map is as a planning tool when developing a course that seeks to integrate EM [20]-[22]. As the EM master concept map provides a broad overview of the “who”, “what”, “how”, and “why” elements associated with an EM it can be a beneficial launching point for determining what topics could be included within a class or the types of activities, as described in the concepts associated with the “how” branch, that could be incorporated into the classroom environment to encourage students’ building an EM.

Another potential application relevant to EM research would be to use the EM master concept map as a starting point for understanding the differences that exist between different populations that are in the process of developing an EM or have been identified as having an EM. Examples include making the comparison between concept maps from expert EM faculty and practicing entrepreneurs/intrapreneurs or perhaps comparing the differences in the EM concept maps generated by first-year students with those that are about to graduate from their undergraduate programs.

## Conclusions

Concept maps are a versatile tool that can be used for the visualization of complex constructs. They have many potential applications within the instructional field including assessment of student development, course evaluation through pre- and post-assessment, and course design. This study sought to develop a master EM concept map that could provide a guide for faculty members who are interested in their students' EM development. The master EM concept map was generated through the collective knowledge of 26 faculty members that participated in a concept map workshop at the KEEN National Conference and confirmed by seven faculty with expertise in EM. The finalized EM master concept map went through a series of revisions and review using the peer-reviewed literature as well as faculty experts to identify where there may be gaps or missing organizational structures that are inhibiting the use of the EM master concept map as a faculty tool.

The finalized EM master concept map provides an overview of the “who”, “what”, “why”, and “how” components associated with EM. This EM master concept map can serve as a guide for faculty members who are interested in developing course materials that may assist their students with EM development but also as an assessment resource for better determining how students are progressing with EM development. Our immediate future work will be experimenting with different scoring approaches that use the EM expert concept map to assess student-generated maps.

## Acknowledgements

We would like to thank the Kern Family Foundation through the KEEN Network for providing the funding for this study. The authors are very grateful for this support.

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## Appendix A

Included in the hierarchical table below are the breakdown of themes identified in the finalized EM Master Concept Map. Themes are organized based upon their categorical branches.

Table 5. EM Master Concept Map Thematic Hierarchical Table

Level 1	Knowledge, Skills & Attributes	Entrepreneur/ Intrapreneur	Modification	Innovation	Creating Value	Extra and Co-Curricular Experiences	Formal Education	Experiences	
Level 2	<ul style="list-style-type: none"> <li>• Career preparation/ skills</li> <li>• Personal attributes</li> <li>• Knowledge</li> </ul>	<ul style="list-style-type: none"> <li>• Process</li> <li>• Company/ Organization</li> </ul>	<ul style="list-style-type: none"> <li>• Intellectual property / Technology</li> </ul>	<ul style="list-style-type: none"> <li>• Intellectual property / Technology</li> </ul>	<ul style="list-style-type: none"> <li>• Value proposition</li> <li>• Gains impact meet needs niche used to help</li> <li>• Stakeholder/ people</li> <li>• Society</li> <li>• Sustainability/ green</li> </ul>	<ul style="list-style-type: none"> <li>• Clubs</li> <li>• Co-ops/ internships</li> </ul>	<ul style="list-style-type: none"> <li>• Pedagogy</li> <li>• Education system</li> </ul>	<ul style="list-style-type: none"> <li>• Personal</li> <li>• Other</li> </ul>	
Level 3	<ul style="list-style-type: none"> <li>• Character traits</li> <li>• Attitudes</li> <li>• Behaviors</li> <li>• Areas/ subjects</li> </ul>	<ul style="list-style-type: none"> <li>• Goal</li> <li>• Teams</li> <li>• Decision-making</li> <li>• Phases</li> <li>• Communication</li> <li>• Collaboration</li> <li>• Benchmarking/ competition</li> <li>• Economics/ finance</li> <li>• Real world problems</li> </ul>							