

# Work-In-Progress: Validation of Connections and Creating Value Assessments

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**Abstract**—This work-in-progress (WIP) research paper reports the initial validation efforts for two Entrepreneurial Mindset (EM) focused indirect assessments. As we face an increasingly global market, graduating engineers with the ability to approach their work with both a technical and business orientation is critical. The Kern Entrepreneurial Engineering Network (KEEN) was created to meet this need. Central to this network is the instillation of EM into current and future engineering students through Entrepreneurial Minded Learning (EML) in engineering coursework. Specifically, an EM is operationalized through the 3Cs: curiosity, connections, and creating value.

At our institution, we developed both direct and indirect assessments to holistically assess students' ability to exercise each of the 3Cs. While the curiosity assessment used was developed externally, our connections and creating value indirect assessments were developed in-house. A previous research team at our institution developed Entrepreneurial Mindset Learning objectives (EMLOs) which guide our implementation of EML in some of our engineering coursework and applied them in the creation of items for both indirect assessments. EFA work was previously conducted and yielded four factors for our connections indirect assessment (integrate outside information; consider social, economic and environmental factors; define connections; make connections within engineering design) with a total of 18 Likert-scale items and three factors for our creating value indirect assessment (creating value within engineering design; attitudes and approach toward value creation; create value for others) with a total of 22 Likert-scale items.

The face and content validity efforts of the connections and creating value indirect assessments are the focus of this WIP. Engineering instructors with expertise in EM were invited via email to participate in an online survey to begin assessing their face and content validity. The validation survey consisted of a subset of items from both indirect assessments. Participants were asked to rate the clearness, relevance, and alignment of the items relative to the construct they measured. The participant feedback is discussed in this study as well as the future steps for validation of the survey instrument.

**Index Terms**—Connections, Creating Value, Validation

## I. INTRODUCTION

Our increasingly global market and context which we engineer solutions within prompted calls over the past few decades to equip engineering students with more than just the skills associated with engineering science [1]. Skills related to empathy, teamworking, communication, and understanding the

social, environmental, and international context of their work are a few of such skills and have since taken prevalence in engineering coursework [2]. In this endeavor, institutions in the US have also identified the importance of the Entrepreneurial Mindset (EM) in preparing their students with these skills and the ability to work in our global context. One such institution is the Kern Entrepreneurial Engineering Network (KEEN) which is a network of universities across the nation geared towards supporting engineering programs to instill an EM into their engineering students. Broadly speaking, EM is a collection of mental habits that target one's impact on society and the ways in which they support it [3]. These mental habits apply KEEN's 3Cs (Curiosity, Connections, and Creating Value) [3] to foster one's EM. Engineering programs have integrated Entrepreneurial Minded Learning (EML) into their coursework to support student development and mastery of EM as well. At our institution, EML has been integrated into both our First-Year Engineering Program (FYEP) and capstone courses to nurture the growth of an EM in our students so that they may apply it in future contexts as practicing engineers.

## II. BACKGROUND

Our institution began its EML integration efforts in 2017 by targeting the standard course sequence in our FYEP. Our researchers and practitioners integrated EML into this course sequence conducting a multi-institutional investigation to better understand how other KEEN universities apply EML in their first-year engineering coursework [4], [5], [6], [7]. This led to the addition of 3Cs-related content to the current curricula so that students may gain familiarity with it and EM and could actively apply it to their work. Positive outcomes related to student performance arose from this effort, encouraging wider integration of EML into the honors course sequence of our FYEP and capstone courses. Members of our institution also instituted Professional Learning Communities (PLCs) to better assist and support instructors in developing and delivering EML content in these courses [8], [9].

The expansion and standardization of EML in our courses prompted the standardization of learning outcomes and an assessment toolkit. This was completed through the creation of Entrepreneurial Mindset Learning Outcomes (EMLOs) and direct and indirect assessments that target each of the 3Cs

[10], [11], [12], [13], [14]. Direct assessments for each of the 3Cs were created with corresponding rubrics that assist both instructors and students in applying an EM lens when assessing work [11], [12], [14]

Indirect assessments aligned with each of the 3Cs were designed. The Curiosity indirect assessment uses Kashdan et al.'s Five Dimensional Curiosity Scale which has previously been validated for use in a first-year engineering context [15]. However, as a similarly validated Creating Value and Connections assessment did not exist, these survey instruments needed to be developed and validated.

#### A. *Creating Value*

Creating value can take multiple forms in an engineering project. Many times those in engineering and business approach this as the triple bottom line of social, environmental, and financial impact. This is sometimes referred to as "people", "planet", and "profit" [16]. The idea of strengthening the social and environmental impact within engineering design and engineering curriculum has been something that has increased in recent years (eg. [17], [18]. While thinking about stakeholders and impact of engineering design benefits all engineers, students from minoritized groups tend to enroll in disciplines like biomedical and environmental engineering at higher rates [19] indicating that focusing on value creation and opportunities for impact could also improve recruitment and retention. Based on this importance creating value is a core component of EM [20].

#### B. *Connections*

Student ability to connect the content they are learning in a course with previous knowledge, experiences and workplace has been highlighted by the National Academy of Engineers as a critical element for the advancement of engineering [21]. Given the importance of this ability to the professional success of future engineers, many scholars use it as a central argument in their work to investigate and enhance students' ability to make connections. For example, Dixon and Brown [22] conceptualized connections as the capacity of transfer learning to investigate the impact of student participation in a multi-year, problem-based/project-based pre-engineering curriculum used by schools in their engineering and technology education program. Another example is presented by Hogg [23], who discussed knowledge transfer as transferring knowledge in the sense of translating technical knowledge to discuss the experience of connecting the technical knowledge to train other professionals in the workplace. In this context, KEEN [24] integrates connections as a core element of the EM model, highlighting its importance of it to development of systems-thinking and the design of innovative solutions.

#### C. *Indirect Assessments for Connections and Creating Value*

Our Connections and Creating Value indirect assessments were created by a previous team of researchers at our institution and underwent Exploratory Factor Analysis (EFA)

to identify corresponding factors within each indirect assessment [13]. EFA work on the Connections indirect assessment yielded four factors: Integrate Outside Information, Consider Social, Economic, and Environmental Factors, Define Connections, and Make Connections. Three factors arose from EFA work on the Creating Value indirect assessment: Create Value within Engineering Design, Attitude and Approach Toward Value Creation, and Create Value for Others. Further validation of the Connections and Creating Value indirect assessments is at the forefront of this work, namely, via content and face validity.

### III. METHODS

#### A. *Content and Face Validity*

This work-in-progress research paper reports our face and content validity processes for the Connections and Creating Value indirect assessments. Content validity refers to the extent to which an instrument's items measure what it was designed to measure. It is typically measured by asking experts to evaluate the degree of alignment of each instrument item to the construct it should assess [25]. Face validity "refers to the clarity, relevance, difficulty, and sensitivity of a test to its intended audience" [26] p. 154]. Face and content validity can be performed via qualitative or quantitative approaches. For example, a qualitative approach may entail introducing experts and potential users to the instrument and requesting their feedback via think-aloud interviews [27]. Feedback surveys and open-ended questionnaires can also be used to gather such feedback - for example, Patrick et al. [28] surveyed a group of experts to identify how well each instrument item measured the intended construct. A benefit of feedback surveys and open-ended questionnaires to collect content and face validation evidence is that they offer the advantage of reducing data collection time and, if necessary, allow for anonymous responses.

Content validity and face validity were performed together in this work. A Qualtrics-based survey was developed that asked questions regarding the relevance, clarity, and essentiality of each item of our instrument. The survey questions were developed following the process of Rodrigues et al. [29]. We administered this survey via email to a compiled contact list of expert faculty who teach with EM to provide feedback on the instrument items. We operationalized experts as engineering faculty who engage with engineering education research (EER), participate in the KEEN network, and previously conducted EER using KEEN's definition of EM. These experts understand the EM framework, what the 3Cs are, and could provide effective feedback regarding the alignment of our instrument items with KEEN's 3Cs. We approached face validity by asking these experts to provide feedback on the clarity of item statements because, as engineering faculty, they fit in with the characteristics of and more readily understand the instruments' future users.

TABLE I  
SURVEY QUESTIONS

A	Do you think the statement measures an element of Connection/Creating Value making skills for students?
B	How relevant is this item to measuring Connection/Creating Value making skills for students?
C	How clear is this item?
D	How essential is this item?
E	Recommendations for improvement of this item
F	Any additional comments about the Connection/Creating Value assessment or items that you think are not captured?

### B. Expert Feedback Survey

The feedback survey asked one Yes/No question for each of the 39 instrument items (Table I, A), three 5-point Likert scale questions (Table I, B-D) and two open-ended questions (Table I, E-F). The survey was split into two parts, containing Connections and Creating Value items respectively, to reduce the cognitive load on our participants. Each participant provided feedback on one of the two groups of items. Feedback data was compiled and organized into a spreadsheet to identify which items should be revised or removed.

## IV. PRELIMINARY RESULTS

Four of the experts invited to offer feedback on the instrument items completed our Qualtrics survey (Response Rate=23%). Two analyzed the items related to the Connections indirect assessment while the other two assessed the items related to the Creating Value indirect assessment.

Question A asked experts “Do you think the statement measures an element of Connection/Creating Value making skills for students?” and the item “I can describe the features of an identified opportunity” from the Creating Value indirect assessment was considered as not measuring the intended construct from both experts who completed this part of the survey. The 13 remaining items had divided decisions, in which one of the experts responded “yes” and the other responded “no”.

Question B asked experts “How relevant is this item to measuring Connection/Creating Value making skills for students?” and yielded seven items as not relevant for at least one of the experts. These seven items are listed below.

#### Connections

- I can evaluate the social, economic, and environmental benefits of a proposed solution to a problem.
- I tend to plan for decisions associated with increasing scale or production when designing a solution.
- I can evaluate the social, economic, and environmental risks of a proposed solution to a problem.

#### Creating Value

- I can identify a failure or area of improvement in a submission, project, or team environment.
- I can describe the features of an identified opportunity.
- I often use lessons learned from failures to improve a solution.
- I tend to extend existing solutions to new situations.

Question C asked experts about the clarity of items (“How clear is this item?”). The Connections item “I habitually assess ‘What if?’ regarding connections between aspects of my design.” was considered not clear by the two reviewers. Six other items from both Connections and Creating Value parts were considered not clear for at least one of the reviewers. The remaining 13 items were evaluated as needing additional revision to improve clarity. Question D asked experts to assess the essentiality of the item at hand and only one item was considered not essential for both reviewers who completed the Creating Value portion of the survey (“I can describe the features of an identified opportunity”). This item was also found to not measure the desired construct.

Based on the expert feedback we received, 23 out of the 39 instrument items should be reviewed to improve the clarity of what they are trying to ask and their connection to the constructs they were designed to assess. The revision of items will be supplemented with the additional feedback experts provided through Question E and Question F. Experts’ recommendations and additional comments discussed themes related to item wording, potential misinterpretation of items, unclear terminologies, and items’ scope. Experts also commented on literature findings regarding the constructs under investigation. For example, the following comment was provided by one of the experts who reviewed Creating Value Items:

“Based on a recent scoping literature review on the term creating value, we found that it is represented in the literature not only externally (benefits to potential stakeholders along the different elements captured in the survey items, innovation, and problem solving), but is also related to exchange of one’s own knowledge and/or skills. It might be worth considering a few prompts related to this area.”

This expert’s EM-related research provided an argument to expand the list of items to assess a new domain of Creating Value that future users could consider when reflecting on the construct in the context of their classroom.

## V. CONCLUSION AND FUTURE WORK

This work-in-progress research paper reported the initial content and face validity efforts for two EM-focused indirect assessments: the Connections and Creating Value indirect assessments. Preliminary results indicate the indirect assessments must be reviewed to improve clarity. Additionally, the inclusion of items that better relate to constructs’ domains, as suggested by the experts, may support the indirect assessments’ ability to measure the intended constructs. Additionally, the ideal number of experts to review an instrument for content validity would be 6-10 [30]. Future work regarding the validation of these indirect assessments involves gathering additional face and content validity feedback from experts. This step is currently underway as we are compiling a second list of EM experts to invite to participate in this initiative. Based on the face and content validity feedback, substantial changes may be made that necessitate gathering another round of expert feedback as well. The process of collecting further feedback and instrument responses will be completed in an

iterative process before moving onto the next step. Following the face and content validity, the Connections and Creating Value indirect assessments will undergo construct validity and additional large scale testing. With the conclusion of the validation process, the results will be disseminated with the community via conference publications.

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