Modifying the VALUE Rubrics to Assess the Entrepreneurial Mindset

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Introduction

In an educational setting it is vital that we as educators are able to assess our learning outcomes and effectively measure student progress towards those objectives. With that being said, what can educators do when they trying to instill a characteristic that they don't know how to asses? The engineering entrepreneurship community is tackling this issue head on, as the increasing popularity of injecting an entrepreneurial mindset into the engineering curriculum has brought some of these "hard-to-assess" traits into the spotlight. A significant driver in broadening interest in this space has been KEEN (Kern Entrepreneurial Engineering Network), a network of institutions committed to making entrepreneurship a core element of the engineering curriculum. Faculty within KEEN want their students to graduate not only with a degree, but also with the ability to see "the big picture", enabling them to recognize opportunity, evaluate markets, and learn from their mistakes [1]. To achieve this goal, the network has defined the entrepreneurial mindset in the context of engineering as the combination of curiosity, connections, and creating value, coupled with engineering thought and action, expressed through collaboration and communication, and founded on character [2].

While the KEEN framework has provided a valuable communication tool around which to organize discussion and facilitate action incorporating entrepreneurship into engineering curricula, it has also raised significant questions around assessment of the framework elements. The constructs captured by the framework are beyond the scope of what engineering faculty are accustomed to teaching and assessing. The abstracted and conceptually overlapping nature of the framework elements further worsens this discomfort. Having a fully vetted example of how the framework might be digested into defined, assessable pieces would be of tremendous value to the network. The purpose of this work is, therefore, to address the need for applied assessment of the KEEN Entrepreneurial Mindset and to explore how the Association of American Colleges and Universities (AAC&U) VALUE Rubrics might fill these gaps.

Literature Review

Assessment of engineering entrepreneurship, defined in the broader sense beyond KEEN, has been under significant study in recent literature and continues to be an area of intense scholarly activity. Purzer, Fila, and Nataraja [4] provide a recent review evaluating current assessment methods. Tools generally cluster into assessing knowledge of entrepreneurial concepts [5], entrepreneurial or innovation self-efficacy [6, 7], or attitudes towards entrepreneurship [8]. Many focus around program evaluation, especially of entrepreneurship minors and similar activities. [9] Contextualized around KEEN specifically, early assessment initiatives [10-11, among others] centered on defining the target behaviors as the framework

evolved. More recently, as the definitions have stabilized, efforts are underway to develop instruments assessing all or part of the framework [12-14].

While all of these tools and instruments are valuable, they all focus on larger assessment of mindset and program outcomes. Less commonly discussed but significantly more valuable to the typical instructor are course level assessments, defined by Wang and Kleppe as the grading work and the direct evaluation of the course. [15] Estell and Hurtig from Ohio Northern University have presented a different approach to course-level assessment as they utilize multiple teams of faculty in order to grade senior-capstone projects. [16] Jones and Abdallah have ventured into the area of performance indicators as a means to pinpoint more specific outcomes in a course. [17] Nayak *et. al.* has worked to compose rubrics that look to bridge the gap between the course-outcomes in a laboratory setting to program-outcomes outlined by their department of Computer Science and Engineering. [18] For Knecht, Moskal and Pavelich, their focus was centralized around measuring and tracking growth in the design program at the Colorado School of Mines. [19] In a study by Dancz, Plumblee II et al, civil engineering students were assessed during their 'Grand Challenge Sustainable Entrepreneurship Projects.' [20] As evidenced by the above, there is significant discussion surrounding course-level evaluation of design content, but the literature is significantly sparser regarding course-level assessment of KEEN outcomes and the Entrepreneurial Mindset. It is apparent that much more work in this area is needed.

For all the course-level assessments mentioned above, there is a cornerstone that is used as the driving force to evaluate those students. The rubric has been this cornerstone for decades, helping teachers track students' understanding of material. Popham defines a rubric as a scoring method that can be used to assess student's developed responses. [21] Rubrics are often viewed only as a way of pointing out the most successful students in the classroom. Perlman, however, believes that a rubric can bridge the communication gap between teachers, parents, and students. A rubric can show characteristics that we as teachers value, which in turn eliminates any ambiguity around a teacher's expectation for their students. [22] When working with rubrics, there are two main scoring approaches that can be used – holistic and analytical. According to Jonsson and Svingby, holistic scoring deals with teacher judgement, as the evaluator makes an overall decision about the quality of the student's work. Analytical scoring tends to be more specific, as the teacher decides on a defined score for different aspects of the assignment. [23] According to Sadler, while holistic grading has been the primary method used for higher education, analytical grading has been used at a much higher rate since the late 1990's. [24] Although the rubric has been viewed solely as an assessment tool for quite some time, recent studies have suggested that it can also be used as a learning instrument. Arter and McTighe suggest that in collaboration with a formative assessment of student's current un-finished work, the rubric can highlight areas that students are excelling in, as well as show opportunities where they can improve. [25] Jonsson and Svingby also note that a great benefit to using a rubric is that it can be incredibly consistent in regards to the use of judgment when assessing specific student traits in class. [23]

A prominent example of rubric use, the VALUE Rubrics developed and published by the Association of American Colleges and Universities (AAC&U) are used as a tool to assess a plethora of characteristics in students at the undergraduate level of education. Developed by multiple teams of faculty and other professionals in the educational field, the VALUE Rubrics consist of sixteen rubrics that were originally created for the LEAP Essential Learning Outcomes. [26] It is important to note that while a common rubric is typically used for grading purposes, the VALUE Rubrics are strictly used for gathering evidence of student learning and include no explicit valuation component. [27] The type of mindset and additional attributes assessed by the VALUE Rubrics closely parallels the type of attributes commonly discussed in connection with the entrepreneurial mindset. This work aims to explore this connection further.

Setting, Purpose, and Research Questions

Ohio Northern University has been a member of KEEN since the network's inception in 2005. The focus of recent KEEN efforts at ONU have been to incorporate the entrepreneurial mindset holistically across the curriculum. As part of their efforts, ONU has taken the framework and created an extended list of outcomes to operationalize the entrepreneurial mindset across the curriculum. The purpose of this extended list is to level-set the definitions of the 3C's, as adopted by the ONU faculty, and to give instructors a more unified and operational set of learning objectives to use when incorporating elements of the mindset into their courses. While not formally adopted throughout the network, this makeshift definition was used throughout this work and is included in Appendix A for context. [3] As this effort has been undertaken, however, it has become increasingly clear that consistent assessment of the KEEN outcomes, even when operationalized into more discrete components, is a significant challenge. From a programmatic assessment perspective, this significantly complicates efforts to evaluate student progress.

The purpose of this work is to address the need for applied assessment of the KEEN Entrepreneurial Mindset and to explore how VALUE Rubrics can fill these gaps. As previously stated, rubrics are an important tool when assessing students in the classroom. By modifying the existing VALUE Rubrics and establishing a connection between the traits found in the rubrics and the traits that KEEN aims to promote in students, it is hoped that they might be able to serve as a consistent and easily deployable assessment mechanism across courses and faculty.

The first goal for this work was to review the applicability of VALUE rubrics. The guiding research question for this phase was: Are the VALUE Rubrics applicable in regards to assessing the Entrepreneurial Mindset that KEEN promotes? Secondly, after this initial review, the rubric components deemed most applicable were extracted and the goal shifted to answering the question: How might the components of the VALUE Rubrics be reorganized around the elements of the KEEN Framework? Finally, after a thorough review of the resulting rubrics, the question again shifted to: How might these reorganized rubrics be modified and/or appended to better evaluate the KEEN Framework?

Methodology

As an initial step, a critical review of all sixteen VALUE Rubrics was conducted, evaluating each rubric with respect to its applicability to the KEEN Entrepreneurial Mindset. Each rubric was evaluated against the 3C's of the KEEN framework and rated based on the strength of that connection. The result of this analysis is included in the table below, where zero indicates no connection and three indicates a strong connection.

VALUE Rubric	Curiosity	Connections	Creating Value
Civic Engagement	2	3	0
Creative Thinking	1	3	0
Critical Thinking	0	3	0
Ethical Reasoning	0	0	0
Information Literacy	0	2	0
Inquiry and Analysis	2	2	0
Integrative Learning	3	3	3
Intercultural Knowledge and Competence	3	3	0
Foundations and Skills for Lifelong Learning	3	0	3
Oral Communication	1	1	0
Problem Solving	0	2	0
Quantitative Literacy	0	0	0
Reading	0	3	0
Teamwork	0	1	0
Written Communication	0	2	0
Global Learning	0	0	0

Table 1: Strength of connection between VALUE Rubrics and KEEN framework elements

Where a possible connection was found, the individual rows seen as applicable were extracted and resorted into a new set of rubrics, organized around the mindset themes of "Curiosity," "Creating Value" and "Connections." An iterative process of revision followed, in which similar rows were combined, achievement definitions were adjusted, and items were resorted or reorganized as deemed appropriate to better capture and describe the relevant mindset. After the new rubrics were complete, they were compared with Ohio Northern University's list of extended KEEN Student Outcomes (eKSOs). The extended outcomes provide a working definition of the C's, broken down to a level of detail comparable to that at which the rubric rows were originally written. This process allowed the identification of gaps in the new rubrics with respect to coverage of the relevant mindset component.

Resulting Rubrics

The final product of the analysis and extraction of the sixteen VALUE Rubrics resulted in three newly modified rubrics that work to closely align themselves with the KEEN outcomes.

These rubrics were labeled "Curiosity," "Creating Value," and "Connections." It is important to note that while these rubrics were created to represent each of the 3C's in the KEEN Framework, rows can be utilized in any way the users see fit. An assignment might leverage a selection of rows from across the set of rubrics, as are applicable to the learning objectives of that assignment, together with additional rubric rows pertaining to the technical content or other assessment dimensions not captured by the 3C's. Additionally, each rubric row was tentatively mapped to the most closely related aspect of the revised ABET 1-7 student outcomes. It should be noted that these are likely to be highly dependent upon the underlying assignment or project which is being assessed, although these initial mappings provide a starting point for implementing faculty looking to combine entrepreurship and ABET assessment efforts.

The Curiosity Rubric focuses on the evaluation of the attitudes of students, as it works to focus on inquisitiveness, skepticism, openness, and thoroughness. While the rubric as developed largely captures the eKSO definition of Curiosity, there are gaps. For instance, one trait in the extended list of outcomes that relates to curiosity – observe trends about the changing world – isn't in the rubric. It is arguable, however, that this element may be better captured within Connections.

The Connections Rubric focuses on the evaluation of students being able to understand the world around them and diverse perspectives on a topic. This is the most extensive of the rubrics, covering a wide range of connection sources. Out of the three rubrics, the Connections Rubric matches the closest with the list of eKSOs. The major gap that still exists between the two is that the rubric lacks the ability to evaluate students on the development of a professional network. This, however, is largely a non-academic endeavor and is not something easily assessed (or appropriate to assess) via a rubric.

The Creating Value Rubric focuses on the evaluation of solving problems, innovative thinking, and risk taking. While at its core the Creating Value Rubric matches closely with the KEEN Framework, it still has a disconnect with eKSOs. The disconnect largely stems from the focus here on the mindset-related behaviors while the eKSOs focus more heavily on skillset items like expressing a value proposition or completing a triple bottom line evaluation. One element which perhaps should be incorporated in future iterations is a rubric row on recognizing opportunities, capturing the eKSO elements pertaining to need and stakeholders.

All three of the rubrics as currently written are included as an appendix to this paper.

Conclusion and Next Steps

A set of three rubrics has been developed based on a modification of the sixteen VALUE rubrics, reframed to fit the KEEN Framework. As previously stated, there are gaps in each of the three rubrics, some with more than others. Work is still needed to test, revise, and polish the text of the rubric rows, as well as to evaluate gaps in the rubric coverage. An initial step will be the distribution of the rubrics among other practitioners around KEEN and the entrepreneurship

education community. Feedback will be sought regarding the rubrics, their mapping within the KEEN framework, and their suitability for deployment in the classroom. Additionally, significant work remains in terms of validation of the rubrics. While they have been developed from highly reliable and validated source material, some revalidation is necessary to ensure good reliability and applicability of the rubrics as redesigned.

The next stage of this work will be to engage with the KEEN Assessment Working Group, a committee of individuals from the KEEN partner institutions with an interest in assessment. The working group is beginning a broader effort to identify, develop, and disseminate assessment tools for the KEEN framework, including a branch looking specifically at direct assessment tools such as rubrics. That group will provide an initial sounding board for the rubrics and their assistance will be solicited in vetting the rubrics among an audience broader than the author's home institution. These discussions will be initiated at the next meeting of the working group, currently scheduled to take place at the 2019 ASEE Annual Conference and Exposition. Provided that these rubrics are, in the broader assessment landscape, still seen as viable at that stage, attention will shift to identifying implementation partners to evaluate their effectiveness in the classroom and collect the necessary data for validation.

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Appendix A – ONU Expanded KEEN Outcomes (3C's only)

1. **Related to Curiosity**
    a. Develop a propensity to ask MORE questions.
    b. Be able to formulate SALIENT questions.
    c. Question information that is given without sufficient justification.
    d. Collects feedback and data from many customers and customer segments.
    e. Recognize and explore knowledge gaps.
    f. Critically observes surroundings to recognize opportunity.
    g. View problems with an open mindset and explore opportunities with passion.
    h. Be able to self-reflect and evaluate preconceived ideas, thoughts, and accepted solutions.
    i. Explores multiple solution paths.
    j. Gathers data to support and refute ideas.
    k. Suspends initial judgement on new ideas.
    l. Take ownership of, and express interest in topic/expertise/project.
    m. Observes trends about the changing world with a future-focused orientation/perspective.

2. **Related to Connections**
    a. Understand ramifications (technical and non-technical) of design decisions.
    b. Identify and evaluate sources of information.
    c. Connect life experiences with class content.
    d. Connect content from multiple courses to solve a problem.
    e. Integrates/synthesizes different kinds of knowledge
    f. Consider a problem from multiple viewpoints.
    g. Persuades why a discovery adds value from multiple perspectives (technological, societal, financial, environmental, etc.)
    h. Articulates the idea to diverse audiences
    i. Understands how elements of an ecosystem are connected
    j. Identifies and works with individuals with complementary skill sets, expertise, etc.
    k. Develop a professional network.

3. **Related to Creating Value**
    a. Identify the needs and motivations of various stakeholders.
    b. Express empathy in identifying problems and exploring solutions.
    c. Create solutions that meet customer needs.
    d. Defines a market and market opportunities
    e. Craft a compelling value proposition tailored to specific stakeholders.
    f. Integrate non-monetary and monetary factors into a triple bottom line assessment.
    g. Applies technical skills/knowledge to the development of a technology/product
    h. Modifies an idea/product based on feedback
    i. Focuses on understanding the value proposition of a discovery
    j. Describes how a discovery could be scaled and/or sustained, using elements such as revenue streams, key partners, costs, and key resources
    k. Engages in actions with the understanding that they have the potential to lead to both gains or losses

Appendix B – 3C's Rubrics

Curiosity	Capstone	Milestones		Benchmark
Inquisitiveness *(ABET-7)*	Asks complex questions about certain problems or issues, seeks out and articulates answers to these questions that reflect multiple perspectives.	Asks deeper questions about certain problems and seeks out answers to these questions.	Asks simple or surface questions about certain issues.	States minimal interest in learning more about certain issues.
Skepticism *(ABET-7)*	Questions information to the highest degree; uses every possible resource to confirm or reject the information.	Questions a great deal of information and works to use resources to affirm their belief.	Questions some information and uses resources to help them find the answer.	Sometimes questions information but doesn't use any resources to find the answer.
Openness *(ABET-5)*	Initiates and develops interactions with people who have differing perspectives; suspends judgment in valuing interactions with others.	Begins to initiate and develop interactions with people of differing perspectives; begins to suspend judgment in valuing interactions with others.	Expresses openness to most, if not all, interactions with people who have different perspectives; has difficulty suspending judgment in interactions with other people but is aware of own judgment and expresses a willingness to change.	Receptive to interacting with people with differing views; has difficulty suspending judgment in interactions with people of differing views/mindsets but is unaware of own judgement.
Thoroughness *(ABET-7)*	Explores a topic in depth, yielding a rich awareness and/or little-known information indicating intense interest in the subject.	Explores a topic in depth, yielding insight and/or information indicating interest in the subject.	Explores a topic with some evidence of depth, providing occasional insight and/or information indicating mild interest in the subject.	Explores a topic at a surface level, providing little insight and/or information beyond the very basic facts indicating low interest in the subject.

Connections	Capstone	Milestones		Benchmark
Connections to Diverse Disciplines *(ABET-7)*	Independently creates wholes out of multiple parts (synthesizes) or draws conclusions by combining examples, facts, or theories from more than one field of study or perspective.	Independently connects examples, facts, or theories from more than one field of study or perspective.	When prompted, connects examples, facts, or theories from more than one field of study or perspective.	When prompted, presents examples, facts, or theories from more than one field of study or perspective.
Connections to Diverse Viewpoints *(ABET-2/4)*	Adapts and applies a deep understanding of multiple worldviews (including their own), experiences, and power structures while initiating meaningful interaction with other cultures to solve complex problems.	Analyzes substantial connections between the worldviews, power structures, and experiences of multiple cultures historically or in contemporary contexts, incorporating respectful interactions with other cultures.	Explains and connects two or more cultures historically or in contemporary contexts with some acknowledgement of power structures, demonstrating respectful interaction with varied cultures and worldviews.	Describes the experiences of others historically or in contemporary contexts primarily through one cultural perspective, demonstrating some openness to varied cultures and worldviews.
Connections to Global Contexts *(ABET-2/4)*	Uses deep knowledge of the historic and contemporary role and differential effects of human organizations and actions on global systems to develop and advocate for informed, appropriate action to solve complex problems.	Analyzes major elements of global systems, including their historic and contemporary interconnections and the differential effects of human organizations and actions, to pose elementary solutions to complex problems.	Examines the historical and contemporary roles, interconnections, and differential effects of human organizations and actions on global systems.	Identifies the basic role of some global and local institutions, ideas, and processes.
Connections to Existing Knowledge (ABET-7)	Demonstrates skillful use of high quality, credible, relevant sources to develop ideas.	Demonstrates consistent use of credible, relevant sources to support ideas.	Demonstrates an attempt to use credible and/or relevant sources to support ideas.	Demonstrates an attempt to use sources to support ideas.

Connections to Personal Experiences *(ABET-7)*	Meaningfully synthesizes and organizes connections among experiences outside of the formal classroom (including life experiences and academic experiences such as internships and travel abroad) to deepen understanding of fields of study and to broaden own points of view.	Effectively selects and develops examples of life experiences, drawn from a variety of contexts (e.g., family life, artistic participation, civic involvement, work experience), to illuminate concepts/theories/frameworks of fields of study.	Compares life experiences and academic knowledge to infer differences, as well as similarities, and acknowledge perspectives other than own.	Identifies connections between life experiences and those academic texts and ideas perceived as similar and related to own interests.
Connections to Problem Contexts *(ABET-2/4)*	Considers history, contexts, and constraints of problem, reviews logic/reasoning, and weighs impacts of solution.	Takes into account history, contexts, and constraints of problem, and is able to start understanding the impact of a single solution.	Able to understand/utilize history, contexts, and constraints of problem, and starts to comprehend that a solution can be impactful to other problems.	Recognizes that the history, contexts, and constraints of problem, but is unable to make connections with how the solution to the problem can be impactful.
Connections to Alternative Solutions *(ABET-2)*	Synthesizes alternative solution paths, bringing disparate ideas together into a novel solution.	Formulates multiple alternative solution paths and can take advantage of a few stand-alone ideas to come to a new solution.	Identifies a singular alternative solution path, and recognizes that it has the potential to help find a solution.	Recognizes only the original solution path and doesn't recognize that other paths may lead to finding the solution.

Creating Value	Capstone	Milestones		Benchmark
Solving Problems *(ABET-1/2)*	Not only develops a logical, consistent plan to solve problem, but recognizes consequences of solution and can articulate reason for choosing solution.	Having selected from among alternatives, develops a logical, consistent plan to solve the problem.	Considers and rejects less acceptable approaches to solving problem.	Only a single approach is considered and is used to solve the problem.
Identifying Strategies *(ABET-1/2)*	Identifies multiple approaches for solving the problem that apply within a specific context.	Identifies multiple approaches for solving the problem, only some of which apply within a specific context.	Identifies only a single approach for solving the problem that does apply within a specific context.	Identifies one or more approaches for solving the problem that do not apply within a specific context.
Innovative Thinking *(ABET-2)*	Extends a novel or unique idea, question, format, or product to create new knowledge or knowledge that crosses boundaries.	Creates a novel or unique idea, question, format, or product.	Experiments with creating a novel or unique idea, question, format, or product.	Reformulates a collection of available ideas.
Taking Risks *(ABET-2)*	Actively seeks out and follows through on untested and potentially risky directions or approaches to the assignment in the final product.	Incorporates new directions or approaches to the assignment in the final product.	Considers new directions or approaches without going beyond the guidelines of the assignment.	Stays strictly within the guidelines of the assignment.