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# Assessing Curiosity in the Engineering Entrepreneurship Context: Challenges and Future Research Areas

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## ABSTRACT

Curiosity is often included as one of several attributes comprising the entrepreneurial mindset. While research on curiosity has been conducted in the field of psychology for many decades, applied research on the construct in the entrepreneurship and entrepreneurship education settings has been lacking. The purpose of this paper is to provide guidance for assessing curiosity in the engineering entrepreneurship education context, focusing on two steps of the assessment process: defining curiosity, a step critical for developing program objectives, and identifying possible sources of evidence. Many unanswered questions remain about how the various dimensions of curiosity apply to the entrepreneurship education context.

**Key words:** Curiosity, entrepreneurial mindset, entrepreneurship education, assessment

## INTRODUCTION

Curiosity is an attribute often mentioned by faculty when discussing programmatic goals for engineering entrepreneurship programs and courses and is often included in definitions of "entrepreneurial mindset." For example, the Kern Entrepreneurial Engineering Network (KEEN), states that, "entrepreneurial minded individuals have a constant curiosity about our changing world and employ a contrarian view of accepted solutions" (Kern Family Foundation, Retrieved 2017). KEEN

continues in its definition of the entrepreneurial mindset that, "In a world of accelerating change, today's solutions are often obsolete tomorrow. Since discoveries are made by the curious, we must empower our students to investigate a rapidly changing world with an insatiable curiosity" (KEEN, Retrieved 2017).

Assessment of entrepreneurship initiatives in the engineering context has been given much attention in recent years. Program directors and evaluators struggle to assess the impact of various educational innovations in entrepreneurship, particularly in regards to assessing the entrepreneurial mindset. Defining entrepreneurial mindset has been problematic, fraught with much debate and controversy in the engineering education community.

The overall goal of this paper is to discuss ideas and challenges in the assessment of one attribute that is often included in definitions of the entrepreneurial mindset: curiosity. The paper begins with an overview of historical work defining curiosity, which is critical for identifying program objectives, and then discusses various sources of evidence that can be used in the assessment process. A central conclusion is that there is currently no clear best practice in the assessment of curiosity as an element of the entrepreneurial mindset. However, tremendous opportunities exist to build on the historical research of curiosity to develop assessment plans, to identify new research areas in the entrepreneurship education context, and to establish best instructional practices for the growing number of educators trying to encourage their students to be more curious.

## DEFINITION OF CURIOSITY AND APPLICATION TO ENTREPRENEURSHIP EDUCATION

Grossnickle (2016) proposes a general definition of curiosity as, "the desire for new knowledge, information, experiences, or stimulation to resolve gaps or experience the unknown" (p. 26). Factor analyses suggest that the construct is multi-dimensional, indicating a depth of interconnected yet distinct dimensions (Reio, et al., 2006). Some of the more widely recognized dimensions are described in Table 1 and are discussed further below.

Curiosity can be categorized by four dimensions, one of which is *focus*. Grossnickle (2016) suggests four factors on this dimension: physical, perceptual, social, and epistemic. *Physical* curiosity, originally theorized by Dewey (1910), is defined as one's exploration and curiosity towards the physical environment. *Perceptual* curiosity involves exploring through the senses to acquire new information. *Social* curiosity involves explorations through interactions with others or a desire to learn about others. *Epistemic* curiosity focuses on the desire to obtain new knowledge or information. Another dimension of curiosity concerns the notion of *breadth* versus *depth* (Grossnickle, 2016). Breadth curiosity refers to the idea that individuals may be curious about a wide variety of topics; depth

***Table 1. Dimensions of curiosity adapted from Grossnickle (2016).***

| Dimension | Emphasis | Description |
|---|---|---|
| *Focus of curiosity* | What are individuals curious about? | Individuals may be curious about their *physical* environment, *social* interactions, *perceptual* or sensory information, or *epistemic* need for knowledge and information |
| *Breadth vs. Depth* | Are individuals focused on many things or one thing? | Individuals may be curious about many different topics (*breadth*) or focused within a single topic area (*depth*) |
| *Reasons for curiosity* | Why are individuals curious? | Individuals may be driven to be curious due to boredom and desire for new experiences (*diversive*) or due to desire to decrease uncertainty (*specific*); Individuals may be driven to be curious due to *interest* in a topic or based on desire to reduce feelings of ignorance (*deprivation*) |
| *State vs. Trait* | Are we considering curiosity as a fairly permanent personality characteristic or a fairly transient state based on context? | Are we considering curiosity as a personality characteristic or a context-specific state? Curiosity as a *trait* refers to an enduring personality characteristic fairly consistent across situations and contexts. Curiosity as a *state* refers to a transient state manifested by situational triggers. |

curiosity refers to a narrower focus directed towards just one topic. *Reasons for curiosity* constitute another dimension (Armone & Grabowsky, 1992; Kashdan, et al., 2009). *Diversive* curiosity is motivated by one's desire to reduce boredom. In contrast, *specific* curiosity is motivated through one's desire to reduce uncertainty through more direct actions. *Interest-type* vs. *deprivation-type* constitute additional reasons for curiosity (Litman, 2005). The purpose of interest-type curiosity is for enjoyment or interest; deprivation-type curiosity is driven by the need to reduce uncertainty and not feel ignorant. The dimension of curiosity that is studied most frequently is *state* vs. *trait.* Trait curiosity refers to personality characteristics that are fairly consistent across many different situations. *State* curiosity is a transient condition impacted by the characteristics of the environment or task at hand (Grossnickle, 2016). To further explain this dimension, Grossnickle notes that, "It is expected that all individuals, regardless of whether they are high or low in trait curiosity, will at times experience particular situations that instigate a state of curiosity" (p. 28).

How do these dimensions of curiosity relate to assessing entrepreneurship initiatives? Are there other dimensions of curiosity that should be considered when developing programmatic goals and related research questions? These are areas ripe for exploration. Jeraj and Antoncic (2013) acknowledge this question, stating that, "several types of curiosity can be applied partly to the entrepreneurship context, although they are generally too broad" (p. 427). They go on to argue that curiosity needs a more specific definition in the entrepreneurship context.

Prior research, such as that conducted by Ferguson and colleagues (2014), could help to determine dimensions to explore in assessment of entrepreneurial curiosity. While not specifically targeting curiosity as a construct, the authors developed a framework for the different knowledge, skills, and abilities that are necessary at the various stages in the innovation process. Similarly, one can

theorize that different dimensions of curiosity might be more or less important at different stages in the entrepreneurial process. For example, breadth curiosity might be more important during the discovery phase while depth curiosity might be more important when developing, sustaining, and improving an innovation. Dimensions targeted for assessment of an educational initiative would of course depend on the overall goals.

Whether engineering entrepreneurial programs should target trait versus state curiosity is an interesting question. At the most basic level, one might wonder whether entrepreneurship programs impact students' trait curiosity. However, one might also wonder whether specific instructional activities (the situational triggers) are more or less influential on students' state curiosity. When directors say they hope to "increase students' curiosity" in a broad sense, they are likely referring to trait curiosity. Yet, trait curiosity is difficult to assess, as it reaches beyond the scope and time-frame of most educational programs. In addition, personality characteristics such as trait curiosity tend to be stable over time and are therefore less likely to be altered by instruction, as compared to state curiosity.

## SOURCES OF EVIDENCE TO ASSESS CURIOSITY IN THE ENTREPRENEURSHIP EDUCATION CONTEXT

While there is a strong need to define and contextualize curiosity in engineering entrepreneurship, one can begin to consider sources of evidence that can be used in the assessment process—which can potentially help in answering the above questions. Table 2 lists several types of sources of evidence for assessing outcomes related to improving curiosity.

The primary source of evidence to measure curiosity has been self-report instruments. Many instruments exist to measure curiosity, primarily focusing on the measurement of trait curiosity. Grossnickle (2016) provides a list of many instruments of curiosity that have been developed, including those listed in Table 2 above. Trait-based instruments generally measure sub-constructs (e.g. persistence in gathering information, interest in exploring and solving problems, a need to acquire new knowledge or to resolve unanswered questions). While trait measures may be interesting to explore in research studies, when used for evaluation, it may be difficult to see changes in trait curiosity in educational initiatives with short timeframes. That being said, evaluation can examine *if* measures of trait curiosity can potentially show changes following educational interventions. For example, Williams (2017) has started to explore whether entrepreneurship activities can impact trait curiosity using Fulcher's (2008) Curiosity Index (CI)—a trait-based scale focusing on the dimensions of breadth versus depth. Most existing trait scales were developed to measure general curiosity and

***Table 2. Example sources of evidence for the assessment of curiosity.***

| Source of Evidence | Description | Examples | Challenges |
|---|---|---|---|
| *Trait measures* | Measures of individuals' curiosity as a stable personality trait | Curiosity and Exploration Inventory (Kashdan et al., 2009); Academic Curiosity Scale (Vidler & Rawan, 1974); Epistemic Curiosity Scale (Litman, 2008) | Relies heavily on self-report; May not be appropriate for assessing impact of short-term initiatives |
| *State measures* | Measures of students' level of curiosity within a specific context | In the context of reading (Knobloch, et al., 2004); Student reflections | Scales do not yet exist in the context of engineering entrepreneurship |
| *Behavioral indicators* | Observations of students' behaviors that relate to curiosity | Curiosity in online behaviors (Dickey 2011); Examinations of student artifacts | Protocols do not yet exist in the context of engineering entrepreneurship |
| *Measures of environment* | Scales measuring the characteristics of the environment and whether these could potentially foster curiosity | College and University Classroom Environment Inventory (Fraser, Treagust, & Dennis, 1986) | More tangential as they do not measure students' perceptions or behaviors |

were not specifically geared to the entrepreneurship education context, with the exception of a scale developed by Jeraj and Antoncic (2013). While this scale is intended to measure entrepreneurial curiosity, the items are not geared towards students in an academic context.

State measures could provide information about the impact of specific instructional activities, courses, and programs on students' curiosity within that given context. These measures are context-dependent, and do not yet exist in the entrepreneurship context. As Grossnickle states, "Despite increasing interest in curiosity within the context of education, the prevalence of measures of trait curiosity imply certain beliefs about the role of individual personality differences over differences in the role of the context to establish and maintain curiosity" (p. 40–41). She argues that task-specific measures need to be developed so that we can understand "how curiosity can be fostered in educational settings" (p. 41). The field of entrepreneurship education, as well as other educational contexts, is in need of context-specific instruments measuring state curiosity that can be helpful when assessing programs and courses. While scales do not yet exist, evaluators can potentially use student reflections to measure students' state curiosity following a specific educational intervention. Reflections are fluid and easy to implement, and can potentially yield information valuable in the eventual creation of state curiosity scales.

Other sources of evidence could target characteristics of the educational environment, to ensure that the environment is suitable for fostering students' curiosity. For example, the College and University Classroom Environment Inventory (Fraser, Treagust, & Dennis, 1986) measures characteristics such as autonomy, student interest, attitude towards students, and student-student relationships, which can be potentially mapped to the characteristics that have been theorized to foster students'

curiosity. Kashdan and Fincham (2004) argue that in order to foster curiosity, the environment needs to promote autonomy, competence, and relatedness in students – concepts that map to Fraser et al.'s scale. Measures like this one could be tangential indicators of whether the environment is suitable for promoting curiosity, but do not provide direct information on the impact of educational interventions on students. However, these types of measures can provide information about what aspects of the environment need to be changed and are worth considering in the assessment of curiosity in entrepreneurship settings.

Research on behavioral indicators of curiosity has been much more limited and has been conducted primarily in the K-12 setting. Grossnickle identified one study by Dickey (2011), in which researchers observed students' online behaviors while playing a game for indications of curiosity. Whether or not observations can be developed to identify indications of students' curiosity in the entrepreneurship context is yet unknown. What behaviors would indicate curiosity in the entrepreneurship education setting? Could analysis of student-created artifacts, such as project-based learning assignments, provide evidence of students' curiosity?

In summary, guidance on how to assess curiosity in the entrepreneurship education context is limited. Questions that need to be explored relating to sources of evidence to assess curiosity include: 1) How can trait measures be applied in the entrepreneurial education setting for research or assessment?, 2) Can an appropriate state measure of curiosity be created for this context?, and 3) What types of student behaviors would indicate curiosity in this context?

## FUTURE RESEARCH QUESTIONS TO ESTABLISH BEST PRACTICES FOR ASSESSING CURIOSITY WITHIN THE ENTREPRENEURSHIP EDUCATION CONTEXT

In order to establish best practices for assessing curiosity within the engineering entrepreneurship context, several areas need to be explored. First and foremost, the field has a need for a definition of curiosity grounded in the psychology literature yet applied towards this specific context. If entrepreneurial educational initiatives are intended to impact students' curiosity, evaluators of these initiatives need to have a clear definition of curiosity. Qualitative research with entrepreneurs, instructors, and students would be helpful in determining how curiosity manifests in entrepreneurship education settings.

Additional research is also needed to determine what instructional approaches are taken by entrepreneurship educators that are intended to foster curiosity. What instructional practices do faculty teaching entrepreneurship engage in, and how do these foster curiosity? How do instructors believe that their approaches impact student curiosity? Can existing instruments be used to begin

to evaluate which educational approaches are more successful in impacting student curiosity? Can repeated state-curiosity interventions over an extended period produce increased trait curiosity?

Finally, much work needs to be done to increase the availability of well-crafted instruments of state curiosity, with strong validity evidence and psychometric properties. Existing instruments primarily measure trait curiosity, which might not be informative in determining impact of activities, courses, or programs, given the relatively short timeline of these educational efforts. However, these measures could have utility for those conducting research on curiosity in entrepreneurship students. For example, do students who self-enroll in entrepreneurship programs possess higher trait curiosity as compared to other engineering students? Rather than relying on self-report data, could behavioral measures of curiosity be developed? Can these tools be embedded into regular classroom assessment? Exploring these questions can help identify best practices in evaluating curiosity.

Unfortunately, the current state of the literature does not provide much guidance for those individuals seeking to increase curiosity or to determine the best assessment approaches. Below are several practical tips for those in this position:

1. Consider the different dimensions of curiosity and which might be most important for the objectives and goals of the educational program, course, or other initiative. Wherever possible, use instruments that measure the dimensions that are most related to the program objectives.
2. While an ideal measure of state-level curiosity does not yet exist in the entrepreneurship education context, consider administering trait-level instruments of curiosity, particularly for longitudinal data collection. This is an area that has not yet been well-explored and could provide interesting insights into whether curiosity as a trait can be impacted by instructional interventions.
3. Consider measures of classroom climate to determine if the instructional strategies being used are aligned with those that are intended to promote curiosity and creativity.
4. Consider collecting qualitative data on curiosity. Reflective activities asking students how various instructional activities impacted their curiosity about a topic or subject may provide valuable insights.
5. When possible, partner with evaluation experts who may know the literature well and be able to identify existing instruments. Evaluation experts may be found in university teaching and learning centers, in psychology or other social science disciplines, or externally at another institution.
6. Remember that no assessment plan, of any construct, will be perfect. Start somewhere and evaluate whether the data collected is helpful for determining whether the educational objectives of an initiative are being met and for determining what improvements need to be made to better enhance student learning or the student experience.

The highly complex construct of curiosity is just one of several attributes that may comprise the entrepreneurial mindset. Other attributes, such as risk-taking, creativity, or opportunity recognition, are also highly complex and have strong bodies of research behind them. The value of aligning evaluation of entrepreneurial programs with this research is tremendous and will result in more meaningful data that can be used to drive program improvement.

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