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Board 366: Rebuilding and Reinforcing Creativity through Assessment in Engineering Students and Practitioners

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WIP: Rebuilding and Reinforcing Creativity Through Assessment in Engineering Students and Practitioners

The Problem

Numerous vision documents for engineers in the 21st century[1,2,3,4,5] specifically mention creativity and innovation as requisite skills for the engineering workforce. However, specific, and purposeful development of creativity as a skill remains elusive in engineering classrooms. The reasons for this are numerous. Engineering core courses are often focused on lessons in which a "correct" solution to a well-constrained problem should be reached as efficiently as is possible**.** The academic environment can have negative impacts on creativity in engineering students. because the elements inherent to creativity – use of non-standard approaches, risk, and learning through failures, are both not amenable to and are actively discouraged in engineering education[6]. In surveys, students did not identify any creativity criteria as part of their engineering curriculum[6]. With these factors in place, by the time students are engaged in upper-level design or graduate studies, any attributes of creativity or innovation have effectively been removed from their skill set.[7]

Engineering can be a comfortable fit for students who do not value creativity. When considering factors that impacted student persistence, students who self-described as "highly creative" were significantly less likely to graduate in engineering than those who viewed themselves as "not very creative;" and the "not very creative students were very comfortable in engineering with a 90% persistence rate[8]. Freshman showed far less design fixity than their senior counterparts on an open-ended design[9], and validated measures were used to determine that freshman were more creative upon entering than their senior counterparts were upon graduation[7]. More concerning is that the loss in creativity also correlated to a loss of creative thinking skills among engineering students as they progressed in their studies.[7]

External influences on curricula are also not helping to focus on skills or abilities. Despite an emphasis by ABET on student outcomes, ABET criteria still are grounded in a prescriptive curricular approach focused on the number of credit hours and breadth of material coverage[10]. Two other driving factors include the fact that engineering faculty are not given training in developing creativity, and more importantly, there is limited guidance on how to assess whether classroom approaches are effective in meeting learning outcomes related to creative development[11]. While individual measures of creativity are well documented, measuring team creativity, and more specifically, the team creative process, is typically an onerous process involving observation of team behavior over a period of time or evaluation of team process reflections. These approaches not conducive to general assessment of engineering classrooms. It is useful to note that we are using a definition of creativity for the engineering domain in which creativity requires both novelty and usefulness.[12]

The Approach

Cropley and Cropley[13] proposed promotion of creativity through assessment; however, their approach was in terms of individuals in the general population. Engineering students and practitioners may exhibit different levels of creativity when working individually versus when they work in a team setting. In this study, we use the idea of promotion of creativity through assessment and use it to purposely develop creativity in engineering students. A creativity assessment rubric developed and validated by previous research (CASPER, see Figure 1) has been implemented in facilitated developmental experiences in several cohorts of freshmen and seniors in general design courses as well as technical design courses.

	0	1	2	Score
Problem Identification / Definition	The problem solution process did not consider additional problem elements or constraints that were not specifically wirtten in the problem statement	The problem solution process considered a problem element or constraint that was not specifically wirtten in the problem statement	The problem solution process considered numerous additional problem elements or constraints that were not specifically wirtten in the problem statement	
Idea Exploration - Fluency	One only solution was considered.	At least two solutions were considered	Multiple solutions were considered	
Idea Exploration - Flexibility	Only one type of soultion or solution space was onsidered	Two types of soultion or solution space was considered	Multiple types of soultions or solution space were onsidered	
Novelty of solution space	None of the suggested solution approaches were novel or contained any novel elements. Only considered standard solutions	At least one novel solution approach or novel solution element was considered. Considered at least one non-standard solution or non-standard solution elements	Multiple novel solution approaches or solution elements were considered. Considered more than one non-standard solution	
Design Fixity / Idea Evaluation	A preferred solution was determined early in the process. Limited constraints were considered	One or two preferred solutions were considered . Ideas were compared based on a few constraints with only one solution developed	Multiple approaches were considered prior to determining a preferred solution approach. Numerous constrainsts were considered and more than one solution was developed	
Final Design - separate evaluation			Total (0-10)	

Figure 1: The Creative Solution Process Rubric (CASPER)

To determine the impact of purposeful, assessment guided instruction on creativity development, we are employing surveys that measure characteristics of creative individuals including the big five personality traits, need for cognition[15], creative identity[16], and mastery and performance motives[18]. Blinded groupings will allow us to compare individual assessments to team assessments of creative process using the CASPR rubric. Through 18 months of work on this project, assessments of design processes and products before and after interventions on these and other cohorts (for baselines) have shown that interventions are promising for rebuilding and reinforcing creativity in engineers.

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