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Teachers' Perspectives on Failure: Impact on Classroom Interactions

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Abstract

This colloquium presentation involves a proposed dissertation topic exploring the role of design failure in pre-college engineering research. The aim of this research is to investigate how teachers' views of design failure impact classroom interactions while teaching an engineering unit. In engineering, the ideal perspective of failure includes embracing it as part of the process and developing persistence that allows one to learn from failure. This, however, is not always the perspective that teachers employ in classroom lessons and thus, can impact the way teachers and students discuss failure while teaching engineering units.

Aim

The purpose of this research brief is to provide an overview for a proposed dissertation topic that explores perspectives of failure in pre-college engineering classroom lessons. The study will investigate how both teachers and students view failure and how they deal with failure when working through engineering design challenges.

Problem

Engineering can be viewed as the "missing core discipline" and the *Next Generation Science Standards* (NGSS) have given teachers no choice but to embed engineering principles into their science lessons since they are now included as part of practice (Miaoulis, 2014). STEM literacy is on the forefront of education but creating STEM literate students is not an easy task and can be even harder for K-8 educators due to their lack of specific content knowledge on engineering topics.

Quite often, the reality of K-12 teaching practices eliminates time for engineering and it is often left out of instruction (Miaoulis, 2014). With the increase of standardized testing and teacher accountability based on these test scores, teaching engineering is avoided. There are no state or national standards specific to engineering, and although they are embedded within NGSS, not all states have adopted these standards and teachers need more support in implementing engineering curricula.

Since K-8 classroom teachers may lack content knowledge in engineering, it is important to investigate how they teach engineering in practice. Specifically, this research will look at how K-8 classroom teachers view design failure. Design failure is when students experience frustrations and struggles in the midst of the Engineering Design Process (EDP), as opposed to end failure, which occurs when the design challenge is over and the prototypes fail (Lottero-Perdue, & Parry, 2015). Typically, for teachers, the word "failure" is associated with accountability reporting and is used to

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discuss students' inabilities to pass classes, a school's low test scores, and other catastrophic issues that could seriously impact the school and the district. Engineers, however, view failure as a pathway to success (Petroski, 2001). The iterative and cyclical nature of the Engineering Design Process (EDP) accounts for design failure and it should be expected that it will continuously occur.

Current Research

When engineering is taught in elementary and middle schools, discussions surrounding failure can take on a more traditional "school view" of failure as an endpoint or accountability measure and resist the proactive, "engineering view" of failure as a critical learning element and part of the EDP (Lottero-Perdue, & Parry, 2015). Teaching a proactive approach to design failure will help students persevere through large, open-ended problems, which has the potential to cross disciplines. Since classroom teachers often lack experience with engineering, they may be fearful of teaching curricula that they are unfamiliar with and other times funding or implementation issues prevent engineering from entering these lower grades (Miaoulis, 2014). The proposed research looks to uncover more information that can help alleviate one or both of these potential issues in urban elementary and middle schools since this study will not only be investigating teachers' views of failure while teaching an engineering unit but it will also be providing teachers with relevant curricular materials.

Current research on the topic is limited so this proposed study design is important to help identify what design failure looks like in a classroom. Specifically, how can teachers pose classroom conversations around design failure to encourage students to persevere? Lottero-Perdue & Parry (2014) have looked at teachers' perspectives on failure and found that even when teachers do see the learning benefits of teaching failure in the classroom, they rarely use the world "fail" or "failure" when speaking directly to the students. Another study found that teachers share their own struggles and come from a perspective where the students should "learn from their mistakes" instead of working strategically to support the students while they experience it for themselves (Barnett, 2005). Furthermore, studies have reported that students can experience extreme frustration and often give up when encountering design failure so it is important for teachers to foster supportive environments (Rutland & Barlex, 2008).

Proposed Study Design

Research Questions

1. What are K-8 teachers views of failure?
2. How do these views impact their classroom interactions while teaching an engineering unit?
3. In what ways do K-8 students deal with failure while working with the Engineering Design Process?

Methodology

The participants of this qualitative research study will be Philadelphia public school teachers and their students. The study will begin in the summer with a week-long professional development workshop. First, the teachers will be interviewed in order to identify their views of failure and then the teachers will complete design

challenges where they will be recorded working through potential opportunities of design failure independently and in small groups. After the data on teachers is collected, the rest of the professional development session will include information for how the teachers can use the Engineering Design Process (EDP) in their classrooms. By participating in this research, the teachers will receive one two-week engineering unit with accompanying materials developed by Engineering is Elementary (EiE).

This same group of teachers will then be invited to participate in the rest of the study by agreeing to use the EiE unit in their classroom with their students. In each classroom, the teacher will be asked to identify a four-person design team that will be observed for the entirety of the unit. Each group of students will be interviewed independently before they begin their engineering unit to identify how the students view failure. The specified design team from each classroom will be observed which will include video and audio for analysis. Following the engineering design unit, both the participating teachers and the K-8 students will be interviewed again to identify the ways in which their view of failure has changed.

Implications

Ideally, research on this topic will help identify ways that strategic problem solving processes, such as the Engineering Design Process, lead students to persevere through struggles both inside and outside of the classroom. Since this broad research agenda is beyond the scope of the proposed dissertation, this study will add to the current research on how engineering units in K-8 classrooms help students see failure as positive and productive. By identifying ways teachers' preconceived views impact the way they help students work through failure, teacher educators will be able to use this information to encourage classroom teachers to openly speak about failure just as engineers speak of failure.

Author Biography

Jessica Cellitti is a second year Ph.D. student with research interests focusing on pre-college engineering in urban public schools. Before entering the Ph.D. program at Drexel, she taught math and science in grades K-12 in New Jersey for nearly a decade. She designed STEM elective courses on topics ranging from civil engineering and astrobiology to robotics. Jessica has two Bachelor's degrees in Elementary/Special Education and Psychology. While teaching she also pursued a Master's degree in Science Education as well as a Master's degree in Curriculum and Instruction in STEM Education as part as NASA's Endeavor Fellowship Program.

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