Understanding Impact of a Design Thinking Intervention on Students' Resilience (Work in Progress)

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Introduction

Recent developmental psychology research has revealed that, in an effort to protect youth from harm/difficulties, current generations of students tend to be more sheltered from challenging opportunities [1]. As a result, students may be less able to cope with stressors and overcome obstacles than earlier generations [2], making them underprepared for today's demanding and dynamic work environment [3]. Many students do not possess the 21st Century skills needed to effectively approach novel problems and produce innovative solutions [3],[4].

In particular, individuals who have been sheltered from challenges in childhood are not likely to possess the level of resilience they need to effectively deal with failures and setbacks [1]. Resilience can be defined as the "process of, capacity for, or outcome of successful adaptation despite challenging or threatening circumstances" [5]. Developmental researchers have argued that youth mainly develop resilience by successfully navigating and overcoming adverse situations [2]. Experiences resulting in successful adaptation can inspire confidence to overcome future challenges and equip students with resources on an individual level (e.g. psychological resources such as self-efficacy or adaptability [5]). These individual resources, consisting of aptitudes, motivation and behaviors, are of key importance because they exist within the individual, and are therefore more reliable than external resources such as family or other social connections [5]. With substantially less academic exposure to challenging, open-ended situations than previous generations, today's students struggle to develop the personal competencies they need to be resilient [1], [2], [6].

Research has shown that resilience is one of the key traits of people who are successful in a fast-paced, ever-changing world [7], [8], [9]. Students who have less experience overcoming failure or setbacks may be less likely to succeed due to not developing key adaptive skills that are pertinent to a dynamic working environment and a world of open-ended problems. Shifting educational instruction to focus on building adaptive skills such as resilience could address this issue. By shifting curriculum and instructional style to more appropriately match the skills required in today's working world, educators can help adequately prepare today's youth for the workforce [3], [4], [6]. Students need exposure to opportunities that will help them develop resilience, and the educational setting offers a safe environment for such opportunities to occur [1], [2]. Educators have a unique opportunity to help equip students with individual capacities for overcoming adversity that could potentially make up for lacking resources elsewhere. One educational approach that has recently gained educators' attention is design thinking. Teaching design thinking as a problem-solving tool exposes students to the five steps of the design process: empathize, define, iterate, prototype, validate. In design-thinking based project courses, students participate in activities where they have the opportunity to 1) empathize with others, 2) try multiple ideas, 3) work with others, 4) receive constructive feedback, 5) reflect on what they have learned and 6) revise their solutions in order to improve their problem-solving approach. Each of these elements prioritizes adaptive skills over factual knowledge, and 2, 4, 5, and 6 in particular relate to aspects of resilience.

By learning a process that prioritizes listening, research, and learning through failure, students of design thinking build leadership capacity by collecting proven tools for future job success, including empathy, curiosity, and resilience. The objective of this study is to explore the effects of design thinking on aspects of students' resilience (e.g. failure tolerance) when taught as a method of problem-solving. Our work-in-progress paper shares details of the summer course design and assessment, including the selection and modification of the resilience instrument, and describes potential benefits of using the resilience instrument for course assessment and individualized mentoring of students.

Background/ Conceptual Approach

Design Thinking and Resilience

Design thinking is considered an effective educational strategy to enhance students' problem-solving abilities and change the way in which they learn [10]. By using a project- or experience-based learning approach, design thinking helps students learn to tolerate ambiguity, handle uncertainty, and make critical decisions [11]. Specifically, the design thinking process engages students in activities to try multiple ideas, work with others, receive feedback, reflect on what they've learned and revise their solutions in order to improve their problem-solving approach. Participation in design-based activities has been empirically linked to the development of students' abilities to successfully learn and adapt. For example, an 18-month long study of a middle school that was designed around project-based learning and design thinking principles showed significant improvements in students' dynamic thinking, ability to think more complexly (e.g. systems thinking) and ability to influence others (a teamwork skill). Content was taught by integrating it into multiple 10-week projects designed to be fun, challenging, and immersive for students, as well as more realistic to what they experience in real life [4].

Another study specifically exposed students to design thinking strategies intended to help them overcome the fear of failure, which in turn can help students adapt and persist in learning. Students participated in design projects where they either created and compared multiple prototypes (iterate) or received constructive criticism from stakeholders (empathize + test), which are two strategies derived from design thinking [12]. The students participating in the stakeholder group throughout the design project tended to seek out more critical feedback on a future project, which then led to improved learning of the course's design principles. Similarly, those in the prototyping group who were able to experiment and revise their prototypes engaged in more experimentation in a future project, which also lead to improved learning of the course's design principles. In both groups, the most profound differences were found for students who were already struggling [12]. A similar study found that exposing students to the design thinking strategies of developing solution alternatives (iterate and prototype) and seeking constructive criticism (empathize and validate) helped lower-achieving students perform better outside the classroom. Further, design thinking interventions have also been directly linked to attitudes toward failure. One study found that design thinking principles changed the way in which students' perceived failure and helped them continue to iterate solutions to complex problems despite setbacks [13].

Experience-based education founded on design thinking can help students become more persistent when approaching complex problems or setbacks, effectively respond to failure, and

improve their overall problem-solving ability [13]. Learning to accept and effectively navigate failure or setbacks is an important aspect of resilience that has benefits not only in educational settings, but across life contexts. Project-based learning approaches, including design, have been shown to effectively transfer from the classroom to real-life settings [11], [14], [15]. This transfer is crucial, as the types of adaptive competencies (e.g. tolerating ambiguity, handling uncertainty, and critical decision-making) design thinking helps build will play a large role in students' future careers that require new learning to solve non-routine problems [14].

Research Methods

The evidence linking design-thinking approaches to important behavioral outcomes, such as resilience, is promising though limited. Further, much of the research remains focused on classroom outcomes, rather than on those beyond the classroom. Our study begins to fill those gaps by implementing a high school camp created around the principles of design thinking. Specifically, the course was designed to help equip both over- and under-protected youth with the skills they need to effectively overcome challenges and adversity by building resilience. An aspect of student resilience - failure tolerance - was measured both at the beginning of the camp and after the camp was completed.

Review of resilience measures

In order to determine the most appropriate assessment of student resilience, we conducted a literature review of available resilience measures and related constructs. This search resulted in approximately 20 assessments measuring constructs such as grit, mindset, resilience, and failure tolerance. We examined the reliability and validity evidence, target population, context of intended use, and applicability of the items to narrow down the list to a few top candidates. Many of the measures, including those of grit and mindset, were inconsistent with our conceptualization of resilience, as they were more indicative of stable personality traits than an individual competency or capacity that could be improved. We utilized a review of existing resilience measures from Windle et al. [16] to rule out resilience scales that were designed for use with adults, that were not well-validated, or that were too context-specific.

For example, the Brief Resilience Scale [17] was well-validated, but primarily used with adult samples and too general of a measure. Other scales designed for youths, such as the Resiliency Attitudes and Skills Profile [18] and the Child and Youth Resilience Measure [19] were too context-specific. Using the criteria mentioned above, we identified the Connor-Davidson Resilience Scale [20], the School Failure Tolerance Test [21], and the Academic Resilience Scale [22] as the best candidates for inclusion. Of these, the School Failure Tolerance test seemed the most appropriate. The reliability and validity of the assessment was deemed adequate, and the intended audience was consistent with the students taking the course (students age 7-17 [21]). The items were comprised of attitudes and behaviors indicative of resilience and the type of personal competencies the course objectives were designed to improve.

Measure Development

The School Failure Tolerance Test consists of 36 items contained in three factors consisting of 12 items each: negative affect after failure, preferred task difficulty, and action after failure (e.g.,

behavioral response) [21]. We were interested in the effects of the course beyond the classroom setting, so items that asked specifically about school were reworded to refer to more general experiences (e.g. completing a task or working on a project). All items were measured using a 1-5 Likert-type scale where 1 indicated "Strongly Disagree" and 5 indicated "Strongly Agree."

Procedure

High school students, ranging from a rising freshman to a rising senior, in a week-long design summer program received and completed the failure tolerance survey on the first day of class as part of their activities for that day. The course lasted five days for six to nine hours per day, during which the students participated in a design challenge and explored a different phase of the design process each day. After the course was completed, the students responded to the survey a second time. Four out of five students completed both the pre and post surveys. Students' responses were then analyzed to determine whether there were any changes in their scores upon completion of the course and to identify issues with interpreting the items prior to administering the survey before and after a year-long course.

Preliminary Results

Scale scores were created for each student by averaging their item-level responses. Then, difference scores were created by subtracting students' Pre-camp scores from their Post-camp scores for each subscale. These descriptive analyses showed primarily positive results (see Table 1). Given the small sample size, statistical analyses would not be appropriate. For the Affect factor of failure tolerance, the average change across students was -.15, with a maximum change of -.33, indicating that students' negative perceptions of failure tended to decrease after completing the course. For the Preferred Difficulty factor of failure tolerance, the average change across students was .21, with a maximum change of .42, indicating that students' preferred difficulty tended to increase from time 1 to time 2. Finally, the average change for the Action factor of failure tolerance was .15, with a maximum of .42, indicating an overall increase in constructive actions in response to failure from time 1 to time 2. The results for this factor were mixed, however, with some students exhibiting a decrease in constructive actions.

Table 1. Changes in Failure Tolerance from Pre to Post.

Student	**Affect**	**Preferred Difficulty**	**Action**
SE6106	0.08	0.33	0.33
JU8888	-0.33	0.25	-0.08
MA5685	-0.17	-0.17	0.42
DE4164	-0.17	0.42	-0.08
Average Difference:	**-0.15**	**0.21**	**0.15**

Given the promising results from the summer pilot, we are using the survey instrument and free-response questions to assess changes in students' failure tolerance during participation in a year-long design course. The course provides an opportunity to test the instrument at multiple time points and with a larger sample size. That study is on-going.

Discussion

The summer program provided an opportunity to test a modified resilience survey instrument with high school students interested in design, architecture, and engineering studies. The camp was structured around the design thinking process, with each day tied to one step in the process. As such, students moved through empathy, definition, ideation, prototyping, and validating as the camp progressed. While engaging in these steps, students can learn to tolerate ambiguity, handle uncertainty, and navigate failure - all skills that make up accepted definitions of resilience. A number of activities during the camp were designed to create a feeling of "failure" for participants, and then to give them a methodology for recovering from that failure point and productively applying the lessons learned. Examples include:

- A modified version of the Stanford d.school's Design Thinking Crash Course activity [23], in which the very first activity is intended to be a "false start." Students are asked to answer a prompt with zero information.
- Group discussion about prototype models, during which the group must come to a consensus on a final design. Inherently, many ideas will be thrown out in favor of others.
- Real-time, full scale prototyping for an installation in the built environment, during which students learn quickly through experimentation and play, refining ideas in real time.

Students were also given the survey at the start of a year-long high school architecture class. While this serves as a benchmark for follow-up surveys, the initial results also proved extremely valuable to the course instructor in an unexpected way: "Rather than simply understanding whether my students are good at math or writing, I now know more important things such as whether students are internally motivated; or terrified of failure; or hesitant to ask questions. Understanding where my students stand from this perspective helps illuminate what might otherwise have been hidden skills or hindrances to learning, and informed the way I interacted with each of them in class as I worked to build not just their knowledge but their resilience."

The teacher's comments on students' projects and report cards stressed the importance of trying something new and difficult, and often noted students' improvement in areas tested on the survey. For example, "I know it's not easy, but I'm asking you to do this because I know you can;" or, "I'm proud of you for taking the initiative to ask questions when you weren't sure what to do next." The survey therefore not only likely shaped students' expectations for the course, but also impacted the instructor's focus on skill-building related to resilience. At the conclusion of the course, we will be able to explore how contextual differences (e.g., informal learning in summer camp versus a graded academic year course) may affect students' willingness to experiment and failure tolerance, and identify whether students' survey responses or reflections are sensitive to the differences in learning environment.

Conclusion

Preliminary pre and post data from a week-long summer version of the course found primarily positive, albeit small, changes in failure tolerance from the beginning to the end of the course for a small group of students. Overall, these findings are encouraging and suggest that design thinking principles are a promising method by which to develop resilience in the form of failure tolerance for students. Future work will examine the effects of design thinking education on resilience over a longer course of time and with a larger sample of students.

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