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Paper: Efficacy of teaching entrepreneurial mindset using a game-like activity

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Efficacy of teaching entrepreneurial mindset using a game-like activity

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Abstract

We developed, 'Thank You for Your Service' (TY4YS), a web-browser based, game-like activity as a way to introduce and reinforce the entrepreneurial mindset (EM) for online or on-site courses, in an exploratory way. Even though there are numerous resources available for introducing EM, the TY4YS activity approach is very interactive and most importantly, instead of teaching (or reinforcing) the entrepreneurial concepts first and then engaging in related activities, the students first play, make mistakes, reflect and learn. When the concepts are subsequently presented (or reinforced), they are more relatable and better retained.

The activity starts with a military veteran describing veterans' issues. The player's objective is to create an end-product to mitigate some of the challenging issues and showcase that end-product at an upcoming veterans conference. The players (students) will make a series of decisions during the activity leading to an end-product that the customers (veterans) find valuable. After each run of the activity, players are given a score and feedback to reflect, so that during the next run they make better decisions and create a more valuable solution from the veterans' perspective. The decisions students make pertain to various stages of the engineering design process — research, brainstorming, prototyping, and testing. Most importantly, students involve the end-users and incorporate customer feedback (ideally) throughout the process. The activity will take fifteen to thirty minutes from start to finish and may be completed multiple times.

EM concepts were introduced in the first week of the first-year 'Introduction to Engineering' course (thirty-six students) and the TY4YS activity was made available two weeks later, as an intervention to reinforce those concepts at an application level, before the start of the final project. The efficacy of using this activity was analyzed by pre and post-activity surveys. In these surveys, the students were asked to self-rate their competency in understanding and applying EM and engineering design process (EDP); they were then given a problem to solve where they can show their EM and EDP understanding on an application level. Results showed that even though students' self-rated level of competency was very high in the pre-activity survey, they displayed poor understanding of EM in solving the provided application problem. In the post-activity survey, the self-rated competency was similarly high, but the displayed understanding significantly improved. In the application problem, students clearly showed the value of involving the customer multiple times in the EDP, in iterative design-and-improve cycles. The further reflection questions in the survey indicated that the students were able to understand EM concepts, make actionable and effective plans to apply EM both in their upcoming courses or side projects, and their future career as engineers.

Introduction

Gamification is an interactive way to promote active learning, especially in an online classroom. It has been tried in a variety of scenarios in engineering education and otherwise [1-3]. A simulated scenario in a game-based activity provides a lot of details to a learner, which if presented in a traditional-lecture style can be both time-consuming and dull. Due to these benefits, it was decided to introduce a gamified lesson in the Introduction to Engineering course for first-year students at Arizona State University from Fall 2020 semester onward.

There is also an increasing interest in incorporating an entrepreneurial mindset in the engineering curriculum, starting at the first-year level [4]. A framework to make this mindset concrete has been introduced by the Kern Family Foundation through a university partnership network [5]. The central ideas are encapsulated into the 3C's: Curiosity, Connections, and Creating value. The 3C's emphasize that the entrepreneurial mindset (EM) is more than business ventures and startups. It is about having a curious mind to identify opportunities, and generate solutions / solve problems by connecting information from various sources, aimed to create value for customers and society. This paper presents a gamified way to introduce EM to first-year students via a simulated experience with a potential customer.

Context in the course

The core objective of the Introduction to Engineering course is for the students to learn and apply the engineering design process (EDP) in their course project. Thus, the first week is spent on explaining various stages of this design process e.g., problem identification and definition, research, brainstorming, modeling, design finalization, prototyping, testing and improving, etc. It has been observed that despite explaining the EDP with numerous examples, students do not fully grasp various characteristics of EDP, for example, the notion that EDP is iterative.

Similarly, the second core objective of the course is to introduce and apply the entrepreneurial mindset (EM). The course project necessarily involves working in teams to develop solutions for a real or simulated customer. Since EM is the real driver and motivator behind the stages of EDP, the EM concepts like the 3C's are also discussed in the first few weeks of the course. It has been observed that despite the perception of understanding, students still do not fully grasp the central idea of combining the EM with EDP, for example, the idea that customers should be involved at various stages in the design process and multiple times through the process. Otherwise, the product that is created at the end may not end up 'Creating value' (the last C) for the customers.

To address both of these issues, an intervention was designed a few weeks after the introduction to EDP and EM, which happens to be just before the start of the final course project. To leverage the benefits of gamification, this intervention was designed to be a web-browser-based, game-like activity called 'Thank You for Your Service' (TY4YS). Along with the activity, a short video reinforcing the 3C's and EM concepts was developed, in addition to reflection and discussion questions for post-activity use.

Thank You for Your Service (TY4YS) Activity

As explained, the central focus of the activity is to apply EM (3C's) along with the EDP. As the students start the activity, they take the role of a recently graduated engineering student, who happens to encounter (out of curiosity) a table of military veterans on the 4th of July parade. There, a military veteran (the potential customer) is raising awareness about veterans' issues. The player is inspired to create a solution for the customers in this simulated scenario.

As the game proceeds, players (solo or in teams) are given options to make various decisions, which are related to the stages of the EDP, as shown in Figure 1 below. The sequence of choices creates a whole tree of timelines.

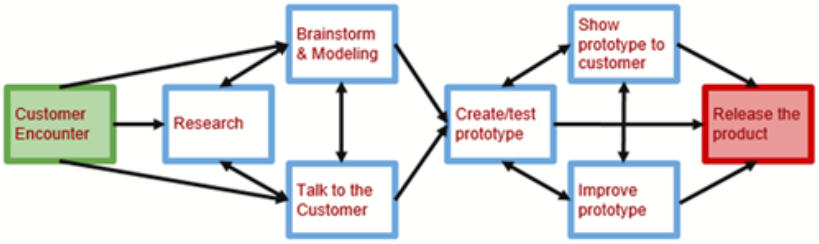

Figure 1. The decision tree of the choices offered to the players during the 'Thank You for Your Service' (TY4YS) activity. These choices are related to the typical stages of the Engineering Design Process (EDP).

The end-product that emerges from the activity, due to various customer interactions, is a phone app which has resources for the veterans. This product is planned to be showcased at an upcoming conference in about two months. Various decisions made by the players have corresponding time-values (in days), and the activity should conclude before the conference. Thus, the players have to consider time-management with a sense of urgency. The activity takes about fifteen to thirty minutes from start to finish, and at the end of it they are given a score along with feedback. The score (out of 100) is based on: 1) the efficient use of time; 2) value of the final product as estimated by the customer at the end; 3) effectiveness in applying the EDP; and 4) customer involvement in the EDP both before and after the creation of the app prototype. Common issues were people wasting time by 'brainstorming' before 'research', or losing the end-product value by not considering the customer feedback multiple times. Iterative application of 'customer feedback and improve' cycles both before and after the prototyping stage are essential to improving the final score.

Students are encouraged to play the activity a second time after receiving the feedback. After the activity is over, a quick discussion follows led by the instructor. A short video is presented that shows the ideal set of choices to maximize the score, and how the 3C's (and the KEEN framework) is related to various choices in the game. Students are encouraged to apply EM in the upcoming project, outside the class, and their future careers as engineers.

The TY4YS activity is part of an EM module, which includes an instructional video, discussions/reflections, and the assessment quiz. All of these resources can be accessed via https://engineeringunleashed.com/card/2427. The EM module is suited for both online or on-site courses, with or without flipped-classroom structure. It is easily integrated into existing courses.

Research Approach and Results

To measure the effectiveness of this gamified intervention, the students are assessed via two survey assignments: one before the activity and one after. Table 1 shows the paraphrased versions of the questions involved in these surveys and their results. The pre-activity survey assignment intended to collect both the self-perceived and the actual understanding of the EDP and EM concepts. Students didn't know about the impending intervention. The post-activity survey assignment had similar questions repeated in it to measure the changes in their responses (if any). The survey assignments were administered in an online version of the Introduction to Engineering course which had thirty-six students. Of these, thirty three agreed for their data to be used in the research. The averages of their responses are reported in Table 1.

Table 1. Summary for the results: questions from the survey assignments before and after the TY4YS activity to measure its efficacy on the student understanding of entrepreneurial mindset (EM) and the engineering design process (EDP)

Pre-activity questions	Results	Post-activity questions	Results
1. "I can apply the steps of EDP in my upcoming course project" **(Measured on 1-5 scale)** 1 = strongly disagree 5 = strongly agree	4.5	(same as the left cell)	4.5
2. "I am familiar with EM and 3C's" **(Measured on 1-5 scale)**	4.5		4.5
3. "I can apply EM and 3C's in my upcoming project" **(Measured on 1-5 scale)**	4.1		4.6
4. "You have a small team in some start-up company. Over the next few months, your team is tasked to create a novel smart device which can autonomously clean couches, tables and chairs. Write the many steps you'd follow to execute this project." **(this survey question is designed for students to show their understanding of EDP and EM at an applied level).** It is assessed via the following rubric:		(same as the left cell)	
a. Overall completeness of the steps considering EDP stages. **(1-5 scale)**	4		4.5
b. How many times were stages in EDP iterated (e.g., customer feedback-research-brainstorm, or feedback-improve prototype)?	0.3		1.4
c. How many times were customers involved before finalizing prototyping?	0.5		1
d. How many times after?	0.9		1.25
There were also various distractor questions about other course topics and information about their self-rated engineering expertise/experience.		Students also reported their activity score reports for each time they played TY4YS.	

		There were also reflection questions regarding lessons learned, their plans to apply 3C's in/outside the class, and the value of EM to future employers.	

Discussion

Overall, the intervention was successful in achieving its intended objectives: increasing the understanding of EDP and EM in a short period of time, before students start the project. This can be observed from Q3 in Table 1: their confidence to apply EM in the upcoming project increased from 4.1 to 4.6. Similarly, as seen in Q4, the number of times they involved the customers in the EDP both before and after the design finalization stage increased significantly. They also iterated the design process more, and had more complete steps overall.

In between the two survey assignments, the students played the TY4YS activity twice, receiving detailed auto-generated feedback each time. The average score of the class for the first attempt was 87 out of 100. In the next attempt, the average score increased to 98 out of 100. The scoring rubric is described in a previous section. This demonstrates the progressively increasing level of understanding of the EDP and EM.

It was interesting to note that in the first three questions of the pre-activity survey assignment, students highly rated their (self-perceived) ability to apply EDP, EM, and 3C's. However, when they were asked to actually apply that knowledge in the Q4 their scores were not that high. In the post-activity survey assignment, the scores in Q4 improved significantly. Students' answers to the reflection questions from the survey also showed a deeper understanding of the EDP. Some of the lessons learned were, regular customer feedback in the earlier stages of EDP saves time later, opportunity for engineering design can come from anywhere, researching the available solutions is important before you try to develop/brainstorm your own, the importance of time management, etc.

The activity was generally well liked, and a common feedback was to make it harder or more complex with more choices! The quality of their responses to the reflection questions in the survey was also very inspiring - especially regarding the value of 3C's to their future employers and their plans to apply EM outside the class e.g., in the engineering clubs, internships, inculcating curiosity in daily life, recognizing opportunity in mundane situations, etc.

In the future, results will be further collected and analysed for a larger student sample over multiple courses, and if resources are available, the activity will be expanded. We are also considering developing similar activities for other courses.

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