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Journey to the Top:
An Experiential Learning Activity for Engineering Entrepreneurship

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Abstract:

The objective of this project was to expose first-year engineering students to concepts associated with an entrepreneurial mindset and to capture their perceptions of this exposure. To accomplish this goal, we developed a board game that focused on the different stages of the design process, the importance of ideation, the risks and rewards that exist in entrepreneurial decision making, and the effects of competition. We piloted the game in a first-year engineering classroom and received feedback from participants at the end of the game. The participant feedback demonstrated that the game was successful in increasing awareness of entrepreneurial concepts.

Keywords: Engineering Entrepreneurship, Experiential Learning, First-Year Students, Game-Based Learning

Manuscript Subject Area: Entrepreneurial Mindset, Engineering Entrepreneurship, Entrepreneurship Education

Subject Topic: Decision making, ideation

Student Level: First-year Engineering Students

Time Required: 60 - 75 minutes

Recommended Number of Students: 20 - 30 Students

Concept:

Game Background: The acceptance of entrepreneurship education as vital and its popularity for use in higher education curricula is steadily increasing (Brooks et al, 2008). Specifically, entrepreneurship education teaches crucial skills including product design and development, prototyping, technology trends, and market analysis (Nelson & Byers, 2010). Consequently, the field of entrepreneurship is gaining traction within engineering education. Engineers benefit from being entrepreneurial, as they are expected to have a positive presence in areas of the workforce beyond technical acumen (Byers, Seelig, Sheppard, & Weilerstein, 2013). According to Byers and colleagues (2013), at least 41 institutions that offered comprehensive engineering programs also offer some form of entrepreneurship education to their engineering students. Also, most of these universities consider entrepreneurship education as more than just learning how to start up an organization, as they consider it a leadership training initiative as well (Nelson & Byers, 2010). Engineering education that focuses on entrepreneurship has proven to positively affect engineering students (Dabbagh & Menascé, 2006; Nichols & Armstrong, 2003). Dabbagh & Menascé (2006) showed that exposing first-year students to entrepreneurship topics early in their academic career helps improve students' perspectives on entrepreneurial engineering. Similarly, Nichols & Armstrong (2003) describe how incorporating engineering entrepreneurship material into an engineering curriculum can enhance many characteristics such as leadership, innovation, and creativity among students. These results support why 58% of the 144 U.S. administrators and faculty surveyed (encompassing 90 institutions) agree that entrepreneurial education should be a required element in the core curricula of undergraduate engineering programs (Peterfreund AR, 2013).

Of interest, however, is how best to implement entrepreneurship education into the engineering curriculum. Research has shown that game-based learning is an advantageous approach to teaching as it promotes engagement and can encourage students to experiment (Drew, 2011; Shaffer, Halverson, Squire & Gee, 2005). Researchers have studied game-based learning in the form of digital games (Chen, Wu, Chuang, & Chou, 2011; Chesler *et al.*, 2013; Ebner & Holzinger, 2007) and board games (Drake and Sun, 2011; Lloyd and van de Poel, 2008). Overall, research within the game-based learning field has demonstrated that games have no negative impact on students in comparison to traditional teaching methods and in many cases demonstrate a positive improvement in outcomes (Bodnar, Anastasio, Enszer and Burkey, 2016). Game-based learning has also been linked to incidental learning in engineering courses – when students learn as a consequence of wanting to complete a game instead of approaching learning with the intent to learn (Ebner & Holzinger, 2007). Further, Verzat, Bryne, & Fayolle (2009) demonstrated that games are an effective vehicle for instilling certain interpersonal skills that have been associated with an entrepreneurial mindset (e.g. teamwork). Taken together, the research indicates that a game-based approach could be an effective means of teaching students about entrepreneurship, and this work explores such an approach.

Our Game

With these game-based concepts in mind, our team developed a board game titled '*Journey to the Top'* – a game designed to replace a traditional lecture session and challenge students to engage in critical thinking related to entrepreneurship. Our game was built upon two key themes. The first entrepreneurial theme was decision making, mostly based on risk-taking or "making decisions and taking action without certain knowledge of probable outcomes" (Dess & Lumpkin, 2005, pg. 148). We utilized the risk-taking concept in the Risk/Reward spaces of our board game (explained further in Appendix B). The second entrepreneurial theme was brainstorming and ideation, which are considered important concepts in engineering. Kuratko and Hoskinson (2014) studied 57 entrepreneurial textbooks and ranked 63 different entrepreneurial concepts in order of importance, finding ideation as the 7th most important concept.

The board game was designed to be implemented with simple materials: a game board, 1 die, 6 different player tokens, 1 stopwatch/timer, 50 Risk/Reward cards, 20 Legal/Ethical Issues cards, 25 Resources cards, 20 Networking cards, 20 Curriculum cards, and 17 Final Question cards. Our prototype of this board game consisted of a board and 6 player tokens, which were in the form of a PowerPoint slide that was projected onto a whiteboard (see Appendix A for the current game board). The game was designed to have no more than six teams. At the start of the game, teams chose a player token, which was placed at the start space of the outermost ring of the game board. Each team was seeded with points so they have the opportunity to take advantage of the Risk/Reward feature of the game. Teams move around the board in a clockwise rotation, and progressively work their way towards the middle of the board, working through the various category cards based on where they land. Movement toward the middle of the board through each of the stages (Brainstorming Stage, Prototyping Stage, Marketing Stage, and the Sales Stage) is based on accumulated points (with 25 points needed to reach the final 'winning spot'). The winning team is the team that reaches the middle of the game board (the winning space) and submits the best answer in the final question. Complete instructions and guidelines for point structure can be found in Appendices B and C. Specific details about each space on the board and associated cards will now be discussed.

Risk/Reward Space: The Risk/Reward Spaces are the most prevalent spaces in the game. Landing on this space grants teams the opportunity to gamble their points in an attempt to double the points they wager and progress closer to the winning space. After landing on this space, the team must decide how many points they would like to gamble and draw a Risk/Reward card. The team does not have to gamble anything, but their turn ends if they choose not to wager any points. If a team has no points to gamble, they cannot draw a card. Also, points that have been deposited into the bank are not allowed to be gambled because they are locked (see "Bank Space" section that follows). Once a team has made their decision on how many points to wager, the instructor draws the top card of the Risk/Reward deck and reads it aloud to the class. If the card is positive, students receive the number of points they gambled multiplied by two. If the card is negative, students lose all gambled points (A detailed example is provided in Appendix D.1).

Legal/Ethical Issues Space: These spaces expose teams to the negative or positive legal or ethical experiences that they may face as an entrepreneur. When a team lands on this space, the professor draws a Legal/Ethical Issues card and reads it aloud. The card either informs the team of the illegal action they have committed and consequence (reduction of points), or commends the team for making an ethical decision (increase in points). (A detailed example is provided in Appendix D.2).
Bank Space: When teams land on the Bank Space, they have the opportunity to lock their points for protection (deposit them in the bank). A team can lock as many points as they desire; however, once they are locked, they cannot be unlocked until the team lands on the Bank Space again. If all points are locked and stored in the Bank, teams are not allowed to use them on a Risk/Reward Space. If a team lands on the Bank Space and wishes to unlock points, they may do so at that time.

Curriculum Space: Landing on a Curriculum Space causes the instructor to draw a card from the Curriculum question card deck and read it aloud. The questions include content that first-year engineering students may have learned during their courses. These questions can be true/false, multiple choice, or short answer questions. These cards only have one correct answer, and players must answer the question correctly to earn points. There is no penalty for a wrong answer (An example of a Curriculum question is provided in Appendix D.3).

Networking Space: The purpose of the Networking Space is to teach students about different scenarios that can occur when dealing with investors, supporters, business partners, or consumers (An example of Networking Space prompt is provided in Appendix D.4). Teams will read through the scenario and will gain points if it is a positive scenario, or lose points if it is a negative scenario.

Lunch Break Space: This space acts as a safe zone (similar to free parking in *Monopoly*). There is no benefit or drawback to landing on this space; however, it does enforce the idea that taking too many lunch breaks does impede success.

Resources Space: The Resources Space awards teams a specified number of points if they answer the question displayed on the card correctly. The questions on the cards refer to different resources found on their campus and how students can take advantage of them. When a team lands on this space, the instructor draws a Resource card and asks the question on the card, if the team answers correctly, they receive points equal to the amount of points specified on the card. If the team answers incorrectly, the team's turn ends. There is no penalty for an incorrect answer (An example of a "Resources" Space question is provided in Appendix D.5).

Final Question Space: When teams have acquired 25 points they can move to the Final Question Space. In order to move past this space and onto the winner's space, teams must win an all-play competition. If there are multiple teams with 25 points on the Final Question Space and an all-play competition occurs, any of those teams can win the game if their answer is chosen anonymously by the instructor. If a team with less than 25 points wins the all-play competition, they are awarded 3 points. The purpose of this space is two-fold. First, it serves as a fun, competitive way to determine a winner, and second, it keeps teams that are behind in the game engaged and interested. The all-play competitions were designed to promote ideation, critical thinking and teamwork, and most importantly, it keeps students engaged (An example of a "Final Question" is provided in Appendix D.6).

Overall, our game not only seeks to provide teams with the opportunity to experience the various components of entrepreneurship such as taking risks, utilizing networking opportunities, and understanding legal issues, but it also informs students about the entrepreneurial resources that their university has to offer. Further, the general purpose of this game is to use game-based learning to expose students to concepts associated with an entrepreneurial mindset.

Student Reaction:
Recalling our goal; to create a board game that could replace a traditional lecture session with an engaging entrepreneurial learning experience. The game was introduced to a first-year engineering class of 36 students. After the completion of this game, the student participants were given an assessment exercise consisting of five questions that asked them to recall, summarize, question, comment, and critique (RSQCC) their experience (Angelo & Cross, 1993). This exercise is provided in Appendix E. For the purpose of this paper we focused on students' responses to Question Two: "Summarize an experience that you had during the game where you felt you were thinking/making decisions like an entrepreneurial engineer." This question allowed our team to understand students' post-game perspectives and whether or not they were thinking about entrepreneurial related concepts.

We reviewed all responses using a grounded emergent analysis approach (Neuendorf, 2002) and found two prevailing themes: brainstorming and decision making. These themes were developed into codes that were used by two undergraduate student researchers to code each participant response. The two coders separately coded the 36 entries and achieved a first-time inter-rater reliability of 0.89 indicating a strong level of agreement (Norusis, 2005).

Specifically, brainstorming was discussed by 11 of the 36 students. For example, one student stated, "When brainstorming different ways to improve [or] design a product, [it] made me feel like an entrepreneurial engineer."

Decision making was discussed by 24 of the 36 students, and one student described that the game challenged them to think critically and make decisions stating,

“We encountered a lot of risky decisions. This whole experience was basically deciding when it is appropriate to risk and how much.”

As stated in the Concept section of our paper, brainstorming and decision making were deemed important during the design phase of the board game; therefore, it is unsurprising, albeit encouraging, that these two themes emerged from the data. Since the students primarily referred to these two themes, we can infer that our board game was covering the desired content appropriately.

In addition to thematic analysis, the RSQCC provided additional useful feedback about the game; in particular, future improvements to the game. Many students commented on their likes and dislikes for the various board spaces and scoring procedures. The responses also showed that some students felt that the game was based more on luck than skill. Apart from the “luck” aspect of the game, students felt that the game still maintained a positive competitiveness throughout its duration. Our team has identified multiple improvement opportunities for future iterations of *Journey to the Top.* These include fixing some of the board spaces, improving the scoring procedure, and making the game less random or driving by “luck.”

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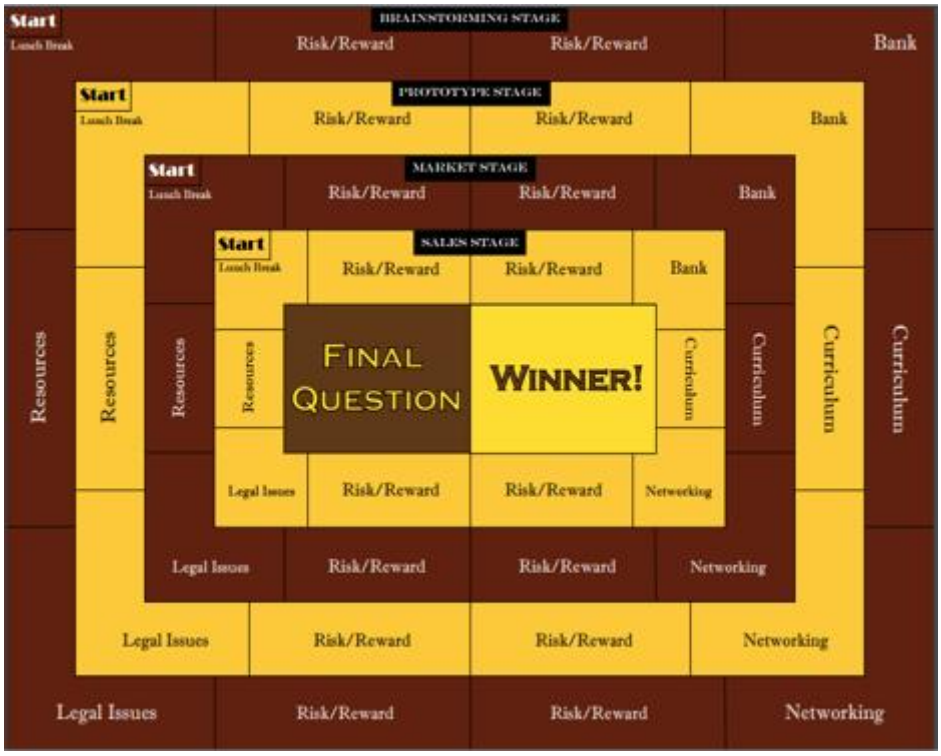
Appendices:

Appendix A: Board Game Design



Appendix B: Professor's Instruction Manual

The Journey to the Top

Instilling the Mindset of an Entrepreneurial Engineer

INSTRUCTION MANUAL

For 2 to 6 Players (Teams)/Ages 10+

This informative game of a life of entrepreneurship will give students the opportunity to step into the shoes of an entrepreneurial engineer and observe and/or analyze the techniques used to achieve success. Players or teams (we suggest teams of 4 or 5 students, with that noted the directions refer to teams and not players) will engage in risky decisions, learn what it is like to budget, and will ideally develop a basic understanding of what aspects are associated with entrepreneurial engineering. This board game is meant to replace a traditional lesson and it is meant to allow students to engage in a competitive environment in an effort to engage them in learning about this material. With this basic understanding, students will have a new positive perception of engineering entrepreneurship.

Game Contents

Game Board
6 Pawns
1 Die
1 Timer/Stopwatch
50 Risk/Reward Cards
20 Legal/Ethical Issues Cards
20 Resources Cards
25 Curriculum Cards
20 Networking Cards
17 Final Question Cards

Professor's Objective

To introduce students to a new sub-discipline of engineering. To make entrepreneurial engineering seem appealing and not intimidating. To use a game as a method of teaching new engineers what it is like to think, act, succeed and fail as an entrepreneur, and to establish a parallel between entrepreneurship and engineering.
Game Setup

Open up the game board and position the board so that all teams can move their desired pawns (You may also choose to display the game board with a projector, in order to ensure that it is in view of all students). Place all of the pawns on the start space of the outer ring; all pawns not selected are to be left in the game box. Distribute points to all teams at the start of the game (We suggest 5 points, as students will be able to take advantage of the risk/reward spaces from the start but will not be too far ahead in the game). Remove all card decks from the box and shuffle them thoroughly. Place each deck in a space reachable by all teams (Putting the decks in the front of the classroom will encourage students to get out of their seats and move around).

How to Play

To start, every team rolls the die, the highest number goes first. If there is a tie, the remaining teams roll the die again. The order of turns follows a clockwise rotation from the team who rolled the highest number. As a professor, you will monitor the scoring for the game and you will be the judge on who wins points from the final questions.

What to Do on Your Turn

To move, teams must roll a die and move their pieces around the game board in a clockwise direction along the outer ring (The first ring is the "Brainstorming Stage") according to the number they rolled on the die. The board is split up into 4 rings that model the journey of an entrepreneur. The outer ring is called the "Brainstorming Stage", the next ring going towards the middle is the "Prototype Stage" followed by the "Market Stage" and the "Sales Stage". Teams start off by moving around the "Brainstorming Stage" until they acquire a certain number of points (10). Once they obtain this number of points, they proceed to the start space of the next stage. This process is repeated until they reach the final stage and acquire 25 or more points. Stages are related to the number points that a team has at one time. If a team has:

1 → 9 points	Brainstorming Stage
10 → 14 points	Prototype Stage
15 → 19 points	Market Stage

20 → 24 points Sales Stage

If a team accumulates 25 or more points at any time, they advance to the final question space in the center of the board. On their next turn, they are presented with a final question.
An interesting aspect of the game is that teams can move backward in the game when things do not go their way. For example, if a team is at the Prototype stage (ring 2) and loses points, falling in the range of points corresponding to the Brainstorming stage (outermost ring, ring1), they return to the start space of that stage. While the team is advancing around the ring, he or she will land on a multitude of spaces. These spaces include a “Risk/Reward” space, a “Legal Issues” space, a “Bank” space, a “Lunch Break” space, a “Resources” space, a “Curriculum” space, and a “Networking” space (see ‘What Do the Spaces Mean?’ below for space descriptions).

The Meaning Behind the Spaces and Their Corresponding Cards

Take a look at game board while reading the following:

Start Spaces: This space is where all of the pawns will start at the beginning of the game, and at the beginning of each level. When a team accumulates the desired number of points to advance to the next stage, they advance to the start space of the next ring (If they are on the “Brainstorming” stage, they advance to the start space of the “Prototype” stage once they obtain 10 points).

Winner Space: This is the final space on the board that each team aims to reach in the quickest amount of time.

Final Question Space: This is the second to last space on the board that each team reports to when they have obtained at least 25 points. In order to move past this space and onto the winner’s space, teams must win an all-play competition. The catch: If a team’s answer is chosen, and they have at least 25 points, they have won **(whether it is their turn or not)**. This means that if there are multiple teams with 25 points, and a final question card is drawn, those teams can win the game if their answer is chosen (in this case, you, the professor, are the judge for this competition, however you must have students submit their answers anonymously). If a team with less than 25 points answers the question correctly, they are awarded 3 points, which gives them a chance to stay in the game. The purpose of this space is to keep teams that are behind in the game engaged. The all-play competition was designed to promote ideation, critical thinking and teamwork, and most imperatively it keeps students involved.

Risk/Reward Space: The Risk/Reward spaces are the most prevalent spaces in the game. Landing on this space grants teams the opportunity to gamble their points in an attempt to gain double the points they wager and progress closer to the winning space. Before the team that lands on this space draws a Risk/Reward card, they must decide how many points they would like to gamble **(make sure they decide what they want to gamble before the card is drawn)**. A team does not have to gamble anything, but their turn ends with that decision. If a team has no points to gamble, they cannot draw a card. Also, points that have been deposited into the bank are not allowed to be gambled because they are locked (see “Bank Space” section below). Once a team has made their decision, the instructor draws the top card of the Risk/Reward deck and reads it aloud to the class. If the card is positive, students receive the number of points they gambled multiplied by two. If the card is negative, students lose all gambled points.

Legal/Ethical Issues Space: These spaces are where teams encounter negative or positive legal or ethical experiences that they may face in the entrepreneurship field. When a team lands on this space, the professor draws a Legal/Ethical Issues card and reads it aloud. The card either informs

the team of the illegal action they have committed and how great of a consequence they will suffer, or commends the team for making an ethical decision with their work.

Bank Space: When students land on the Bank space, teams have the opportunity to lock their points for protection (deposit them in the bank). If all points are locked and stored in the bank, teams are not allowed to bet them when a Risk/Reward card is drawn. A team can lock as many points as they desire. Therefore if a team locks 15 points, that team guarantees a spot in the Market stage (ring 3). However, once they are locked, they cannot be unlocked until the team lands on the Bank space again. If a team lands on the Bank space and wishes to unlock points, they may do so at that time.

Lunch Break Space: This space acts as a safe zone (much similar to free parking in Monopoly). There is nothing good or bad about landing on this space, however this does enforce the idea that taking too many lunch breaks does impede success.

Resources Space: The Resources space awards teams a specified number of points if they answer the question displayed on the card correctly. The questions on the cards will refer to different resources found on the university campus and how students can take advantage of them. When a team lands on this space, the instructor draws a Resource card and asks the question on the card, if the team answers correctly, they receive points equal to the amount of points specified on the card. If the team answers incorrectly, the team's turn ends. There is no penalty for an incorrect answer.

Curriculum Space: If a team lands on this space, the instructor draws a card from the Curriculum deck and reads it aloud. The questions include content that first-year engineering students may have learned during their courses. These questions can be true-false, multiple choice, or short answer questions. These cards only have one correct answer. Teams must answer the question correctly to earn points and there is no penalty for a wrong answer.

Networking Space: The team who lands on this space draws a card from the Networking deck and follows the instructions on the card. The purpose of the Networking Space is to teach students about different scenarios that can occur when dealing with investors, supporters, business partners, or consumers.

Appendix C: Point System Overview

Table 1: Stages of the Board in Relation to Team Points

Appendix D: Card Examples

D.1.1: An example of a scenario that can play out if a team lands on a positive Risk/Reward space:
Card: “You started a Kickstarter and generated enough funds to begin refining a working prototype.”
A team is in the “Prototype Stage” and gambles 5 of their 10 points. Then, if a positive card is drawn, they obtain 5x2 points from the gamble (10), which brings them to 20 total points and allows the team to move to the “Sales Stage” of the board.

D.1.2: An example of a scenario that can play out if a team lands on a negative Risk/Reward space:
Card: “You chose to continue with the production of your product despite some flaws in your design to save money. Unfortunately, the low quality of the product hurts sales.”
A team is in the “Prototype Stage” and gambles 5 of their 10 points. Since the card is negative, they lose the 5 points that were gambled and end up with a total of 5 points, which brings them back to the “Brainstorming Stage”.

D.2: An example of a card from the Legal/Ethical Issues deck could be:
As a business owner, you did not provide your employees with safe working conditions. The Occupational Safety and Health Administration (OSHA) conducted an audit on one of your facilities. You did not meet standard regulations and you were fined a hefty amount. (-2 points)

D.3: An example of a card from the Curriculum deck could be:
What are Variable Needs?

1. Needs that are fundamental
2. **Needs that change over time**
3. Needs that are obvious
4. Needs that are non-obvious

Correct answer earns 1 point

If a team answers with the correct answer (b), the team is awarded 1 point to their total score. Luckily, guesses are not penalized, and a wrong answer does not earn negative 1 point. Guesses are encouraged because it promotes participation and critical thinking amongst a team. This statement is true for Resources cards as well.

D.4: An example of a card from the Networking deck could be:
You decided to join a like-minded business partner and thus, cut your expenses in half (+2 points)

D.5: A potential question a team can encounter from a Resources card could be:
One of these courses is not a requirement for the entrepreneurship minor. Which one is it?

1. Principles of Marketing
2. Entrepreneurship & Innovation
3. New Venture Development
4. Financing & Legal Aspects of Entrepreneurship
5. **Calculus I**

Correct Answer earns 2 points

D.6: A potential question a team can encounter from a Final Question card could be: