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Teaming Tribulations: Using a Role Playing Game to Improve Teaming Outcomes

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Teaming Tribulations: Using a Role-Playing Game to Improve Teaming Outcomes

Abstract:

This paper discusses the development and implementation of a board game intended to simulate conversations and debates or negotiations that may occur in design-based projects. One of the challenging tasks for a design group is learning how to collaborate and debate in a constructive and productive way. This study gives an overview of simulations and games used to assist pedagogy and efforts at improving teamwork in design courses. This information is utilized to discuss the implementation and effect of a pedagogical board game, "Teaming Tribulations." This game is intended to simulate the arguments that might occur within a design team discussion in a zero-stakes environment. In Teaming Tribulations, students are asked to create a quick design in response to a simple prompt. They then share their designs during the judgment-free "Concept Generation Phase." In the next phase of the game, "Concept Selection and Debate," they must debate with their teammates to select the best design to submit for their fictional group project. The game is given a twist as two factors, namely the initial biases (which design that they must initially defend and entice others to vote for) and personality types (how they interact with other players) of each player, are both determined by randomly dealt cards. This role-playing causes the students to step outside of their comfort zone and internally reflect on how they share their opinions normally versus how others might make a similar point. In the "Grading" phase of the game, the team receives a score based on if they were able to receive a majority or total consensus. The objective of implementing this game within a classroom environment is to start the discussion on teaming, as well as provide a low-fidelity simulation of the design process for comparison during the semester. Later in the semester, concept selection methods are taught with the reminder that it is not ideal to judge based on initial biases and gut feelings.

The paper is a further developed version of a work-in-progress paper from last year's conference and includes three semesters' worth of survey data from two institutions. Students found the game to be enjoyable, useful as a framework to describe issues with teaming, and identified archetypes that they would like to see in a team.

Introduction

Teaming is one of the most challenging aspects of an engineering design project, especially in the college setting. Due to the complex and multidisciplinary nature of their projects, engineering students must learn how to work effectively on a team, as the majority will be expected to work as part of a team upon graduation. The projects they will face during both their academic and post-academic careers will involve problem-solving and critical thinking, and the unique skills and perspectives of each team member are necessary to arrive at effective solutions. This paper introduces a pedagogical boardgame aimed at simulating debates and negotiations within an engineering exercise, as well as the study planned to track the changes.

A diverse team has people with different backgrounds, experience, and ways of thinking. This can lead to a wider range of perspectives and ideas that can improve problem-solving and decision-making. The wider pool of knowledge and experience of a diverse team can result in more creative and innovative ideas. Finally, a range of backgrounds can increase the team's ability to understand and empathize with different customers and stakeholders. Allowing for a

culture of inclusion strengthens the output of a group and maximizes the benefits of a diverse team [1-2]. It is therefore critical for engineers to understand how to work with others and give and accept criticism in a way that is respectful and builds up the team rather than alienating members.

During the 2020 Covid-19 pandemic, many teachers switched to online education, and the methods that faculty use now in and in the future will and should change because of this experience [3]. The lessons learned in online education cannot be understated. While it is critical that faculty work on improving their online teaching techniques, they must also optimize the benefits of in-person learning when human-to-human interactions take place. One of the largest benefits of in-person learning is the opportunity of social interaction. One study found that allowing students to interact with each other in a flipped gamified environment provided better learning outcomes when compared with online or traditional education [12]. The impact of this pandemic is expected to affect social skills of those who were students during that time [4]. In-person learning provides opportunities for students to socialize with their peers and build relationships. It is important that, rather than taking these features for granted, faculty take advantage of utilizing this resource to its greatest advantage. Post-Covid education should not simply return to lectures and typical learning but instead focus on maximizing the benefits of the in-person experience by maximizing active learning opportunities.

Pedagogical Boardgames

Many boardgames are adaptable to a virtual environment, but a 2018 study found that when given the option, many players will opt for a physical board game over a virtual equivalent [5]. The idea of gamifying learning, or pedagogical boardgames has been used in many fields in K-12 and higher education [6-8]. A study on the use of medical boardgames for undergraduate and postgraduate students found that boardgames could either help student enjoyment of a given topic, or also have an impact on knowledge retention of a given topic. Roleplaying games, in which the students take on the role of a patient or physician were a common feature in medical games [9]. Boardgames can be a fun way to build motivation in a class and introduce students to a topic. Having a set of rules with flexibility of strategy and methods takes students out of the mindset of having an action be "right or wrong," –often formed when taking a quiz or answering a question in class– and puts them into an open play mindset. This mindset is critical within a design course; having fun and playing with humor can lead to more creative behaviors [10].

Teamwork in Design Courses at Penn State Erie and University of Oklahoma

The boardgame in this study was used in classrooms as two schools: Penn State Erie, the Behrend College (Behrend), a small undergraduate focused institution, and the University of Oklahoma, a public state university. The design courses taken by students at Behrend include a semester long first-year introduction to engineering program (EDSGN 100) as well as in the first semester of a yearlong Mechanical Engineering capstone program (ME 448). In EDSGN 100 students are assigned to teams of up to 5 students either randomly or based on their schedule availability. In ME 448 students are given the option to self-select teams, but some teams are formed by the faculty running the course for students who do not have a team. The technical expectations of the EDSGN 100 project are light enough that any student can complete all mandatory tasks, while the ME 448 course requires each individual student to take on tasks of their own within the group while also managing the team progress together.

To help the students work together in teams at Behrend, both classes require students to write a Team Contract at the start of the project. The document is created so the groups may set their expectations, norms, and consequences for a lack of participation. The ME 448 students also use CATME [11] to evaluate their work and their teammates work at 3 checkpoints throughout the year and are encouraged to revisit their Team Contract when there is significant dissatisfaction between teammates. Students in EDSGN 100 are given paper feedback sheets to rank their teammates at the end of the project but are not required to revise their team contract during the project.

The design and team-building courses taken by Industrial and Systems Engineering students at the University of Oklahoma include a semester-long first year introduction to engineering program Pathways to Engineering Thinking, a second- or third-year professional skills course, Professional Responsibilities and Skills of Engineers and Scientists, and concludes with a single semester capstone program Capstone Design for Industrial and Systems Engineering.

In Pathways to Engineering Thinking, students are assigned to teams of up to 4 students semi-randomly with consideration toward the non-isolation of members of underrepresented demographics. Teaming skills are supported in this first-year engineering and design course through CATME-inspired peer evaluations. In Professional Responsibilities and Skills of Engineers and Scientists students are assigned to teams of up to 5 students using CATME's team-building software. Teaming skills are supported in this power skills development course using CATME's peer evaluations.

In Capstone Design for Industrial and Systems Engineering, students are assigned to teams of 3-4 with consideration given to project topic interests. The number of students on a project is defined such that there is adequate work for all members to stay productive. Capstone Design for Industrial and Systems Engineering students perform evaluations of their teammates work at 3 checkpoints throughout the year. Each student gets feedback on their performance with their team, and potential problems are addressed by the course instructor.

Across all the design courses there are challenges when working with a team. Students may struggle with communicating their expectations, which can lead to misunderstandings, miscommunications, and negative predispositions towards working in a team [13]. Collaboration can be challenging when students have different opinions or goals. Other challenges can occur due to differences in behavior or personality [14-15]. These include those who do not participate at the same level of their teammates, those who are overly critical with their teammates, those whose personal relationships outside of class affect their behavior within the team, and the over/underrepresentation of extraverted and introverted students respectively. Students who are not prepared to work within a team are more likely to have mismanagement and conflict [16] These challenges can impact group performance and student satisfaction.

Teaming Tribulations

Teaming Tribulations was designed as an in-class exercise aimed at simulating an debate within the design process. The game takes place over three main phases: Concept Generation, Concept Selection or Debate, and Peer Review. The three phases provide a highly simplified simulation of the steps of a typical design project.

Concept Generation

During concept generation the players draw one "Design Prompt." These design prompts are lighthearted and meant to generate quick, silly, ideas. Examples include "Fancy Snowshoes," "Invisible Coat," "Dog hotel," etc. The players are then given 2 minutes to draw and name their design. The players then share their design with each other in a judgement-free environment.

Concept Selection/Debate

In this phase students need to reach a consensus on which design that their team will present and to be graded. However, both the design that they debate for at the start of the phase, as well as the method in which they debate, are determined by two cards that they draw between the Concept Generation and Debate rounds. The "Personality Card" determines how they will communicate during the debate, while the "Initial Bias" card determines which card they will initially favor. The initial bias cards will have an option of a player number, the player's own design, any design but the players, or an odd or even design. The Personality Card types can be seen in Table 1.

During the debate stage players have four minutes to come to some sort of consensus. At the end of the four minutes, the players must all simultaneously point to a design that they vote for.

Table 1: Personality Card Types

Personality Card	Description/Rules
Coach	Try to make sure every other player talks
Wallflower	Can only speak if directly asked to talk
Chipper	Can only compliment designs and is unable to critique
Doom and Gloom	Can only critique designs and is unable to say something positive
Slacker	Participate as little as possible, do not try to help
Besties	Roll a die to select a player to agree with as much as possible
Nemeses	Roll a die to select a player to disagree with as much as possible

Peer Review and Grading

The game ends as a type of prisoner's dilemma, they get points for selecting their initial bias, but the team will "fail" if there is no majority vote. During this round the team earns points for each player that met their initial bias card, that stayed true to their personality card, and the team earns points if they had a majority or unanimous agreement on which design they selected. The points are added up and the students are given a mock in-game grade based on their points. The students are informed that the in-game points are simply for fun and do not have any effect on their course grade.

Game Development

This game was inspired as part of a workshop at Capstone Design Conference in 2022. The goal of the workshop was to create a game that could simulate all or part of the Capstone design process. The group in this workshop decided to focus on teaming, as all the faculty involved had experienced challenges with their capstone students regarding teaming. The game started off as "Capstone Conundrums" and the initial design prompts were brainstormed at the conference.

The game was playtested at several different locations in summer of 2022; Capstone Design Conference, with engineers in industry in Erie, PA, ASEE's Annual Conference, and with EDSGN 100 instructors prior to the start of the semester. Each play test resulted in clearer instructions, added roles, prompts, and fine tuning for an appropriate amount of time for the rounds.

Discussed further in "Class Implementation," the method in which the game was included in the class, and the supporting lessons, were adjusted based off student feedback. After the first semester, the lecture given in the class prior to the boardgame included an overview of conflict management styles of avoid, accommodate, compromise, compete, and collaborate. Between the first and second game, instructors were asked to lead a discussion on how to give a proper critique, and the difference between critique and negative criticism.

Class Implementation

The game was implemented in classes across two universities in the first-year and capstone engineering design courses starting in fall of 2022. Groups of 4-5 students received a box set of the game, as shown in Figure 1. Students play two rounds of the game, receive their "team grades" and then discussed how they felt playing the different roles. They also shared their final design selection with the class, most of which had humorous designs. The game was introduced prior to the Team Contract assignment at the start of their engineering projects.
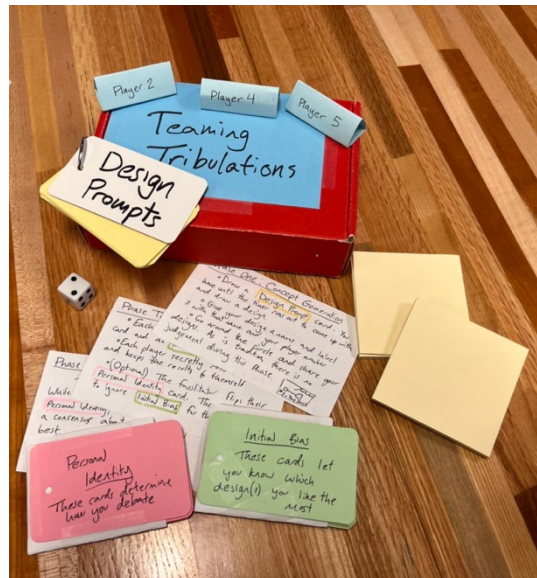

Figure 1: A copy of the game as received in class

Table 2: Semester Implementation and Locations

Semester	Institutions	Courses	Data Collected
Fall 2022	Behrend	EDSGN 100, ME 448	Student comments and interviews
Spring 2023	Behrend	EDSGN 100	Pre and Post Survey
Fall 2023	Behrend and the University of Oklahoma	EDSGN 100 (Behrend) Capstone Design for Industrial and Systems Engineering (UofO)	Pre-Survey, Grades, and Game Scoring Sheets
Spring 2024	Behrend and the University of Oklahoma	EDSGN 100 (Behrend) Capstone Design for Industrial and Systems Engineering (UofO)	Pre and Post Survey, Grades, and Scoring Sheets

Preliminary Semesters (Fall 2022 and Spring 2023)

The game was implemented in fall 2022 in both the ME 448 and EDSGN 100 classes at Behrend. Students appeared to enjoy playing the game, and it worked as a quick ice breaker activity. Several students in ME 448 stated that while they enjoyed the game, they did think it was more fitting for first year students.

Several EDSGN 100 students were informally interviewed after the conclusion of the fall 2022 semester. These students were asked what they thought of the game, and whether they found it useful for teaming. Their reactions were positive. "It was a different take on learning about teams, and it was really fun to see how people played different personality cards." "I really liked it because I think it was a good way to introduce students to the concepts." A student did note that some EDSGN 100 students would benefit from a lesson on critique (helpful details that could improve a project) vs criticism (stating if they liked or disliked an idea without follow up.)

In spring 2023 the game implemented in EDSGN 100 was followed by an in-class survey which will be repeated at the end of the semester. Students who opt into the study will also have their team adjustment grades analyzed at the end of the semester to see if there is any correlation between a student's belief about teams and how they perform on a team, as well as to see their insights-based teamwork before and after the project. A copy of the survey is in Appendix B.

Multi College Implementation (Fall 2023 and Spring 2024)

For the standardized implementation, students were given the game in groups of 4-6 at the onset of their class project. Students created a quick design, received their personality and initial bias cards, and voted on the groups design. After completing the game, the teams assessed how they performed: whether they were true to their personality card, and if the initial bias on their card was the selected project (through either majority or unanimous vote). They were asked to fill out a scoring sheet (Appendix C) for each game that they played. Each group played two rounds, with different personality and initial bias cards the second round. After completing both rounds, they received the scoring method to calculate how well their team did in the game. The score of each round was based off two components: the summation of the individual grades and the amount of points the team received by turning in a majority or unanimously voted project. The scoring methods are listed in Table 3.

Table 3: In Game Grading Calculation

Component	Score
Individual Score: Initial Bias	Each student adds 5 points to the team score if the design which won by majority vote matches the criteria on their Initial Bias Card
Individual Score: Personality	Each student adds 5 points if they stuck to their assigned Personality Card during the debate (This is assessed by self and teammates)
Individual Total:	Sum of the individual scores multiplied by 5/X where X was the number of people playing the game. (This calculation was so the total score was independent of the number of students.)
Group Vote Score:	60 points if unanimous, 40 if there is a majority, 0 if there is no agreement
Final Score	Group vote score + Individual total

After the in-class board game, students were asked to provide feedback via an online survey during the week following the game. In Spring 2024 students will prove feedback at the end of the semester and the authors will track if students' perception of teamwork changed throughout the semester.

Results

The game was played in EDSGN 100 for Spring 2023 14 participating in survey), Fall 2023 (15 participating in survey), and Spring 2024 (27 participating in survey) and was playing in the ISE Design Capstone in Fall 2023 (4 participating in survey) and Spring 24 (28 participating in survey). Following the in class boardgame, students were asked to participate in a voluntary survey. In the survey, many students ranked the game as enjoyable, helpful, and clear to follow the rules, as seen in Figure 2.

Students were asked "if you were to create your ideal engineering team, which personality would you want to include, and which would you want to exclude?" The majority of students saw Coach as a favorable personality to include on a team, as seen in Figure 3, with only 2 students stating they would prefer to not have the coach. One of the two commented further, stating that they would prefer to not speak up in a meeting and stated that they were not extroverted. Chipper and Doom and Gloom were also seen as favorable characters to have, although not universally. No student listed the slacker as a character they would like to have on a team.
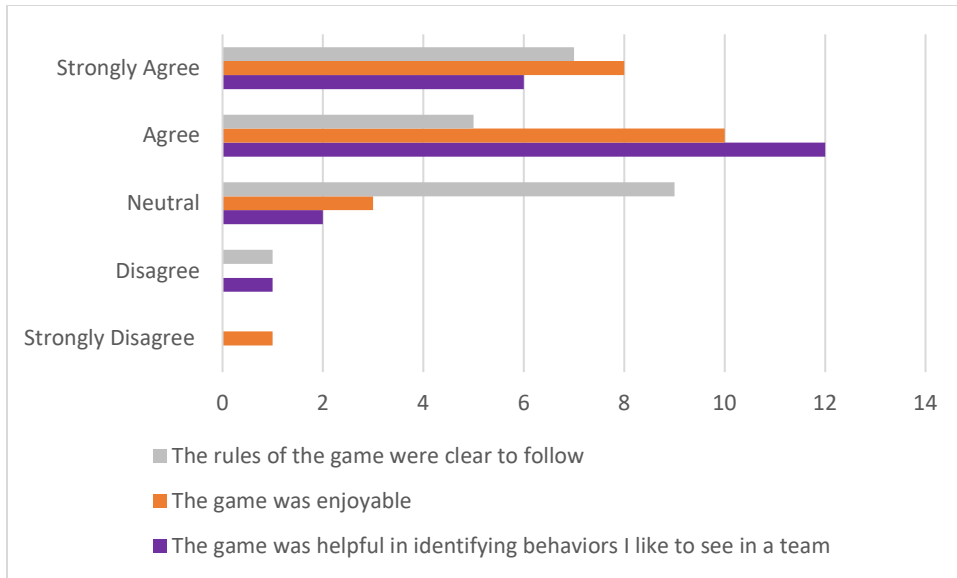
Figure 2: Student Ranking of the Ease, Usefulness, and Enjoyment of the Game (Aggregated results from Spring 2023, Fall 2023)
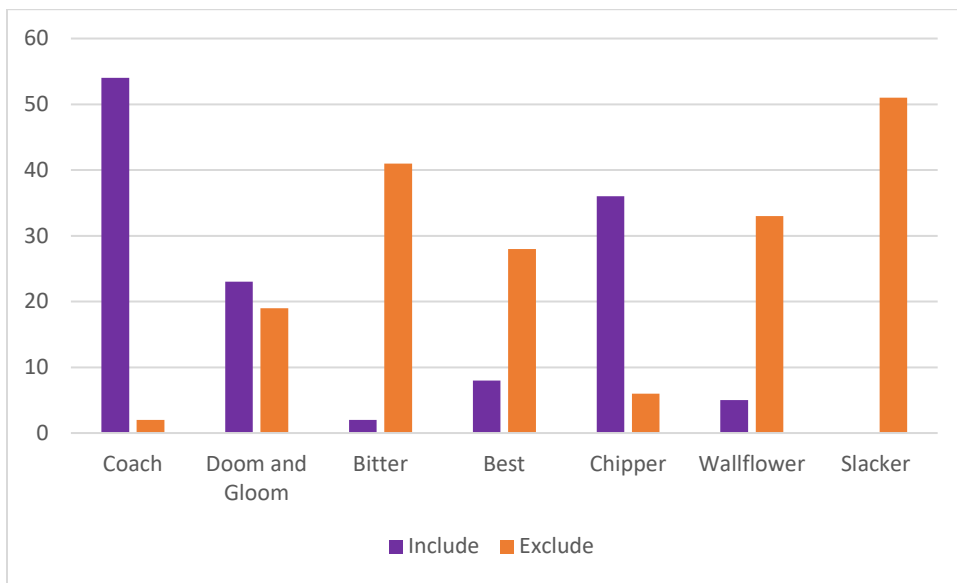

Figure 3: Student selection of character types on their ideal team when asked "which personality types would you want to include on your team, and which would you want to include." (Aggregate Results from Spring 2023, Fall 2023)

One interesting set of results stemmed from the question "What is your preference on a class project?" in which students could state if they preferred working alone or in a team, and how strongly they felt about their choice. The first-year students at Behrend were much more likely to state that they preferred working alone compared with capstone students. It would be interesting to see if this preference correlates with college, year, or if it changes after an in-class project for either group. The authors anticipate having results on changes in perception of the students at the end of the spring 2024 semester, and will present the result at the annual conference.
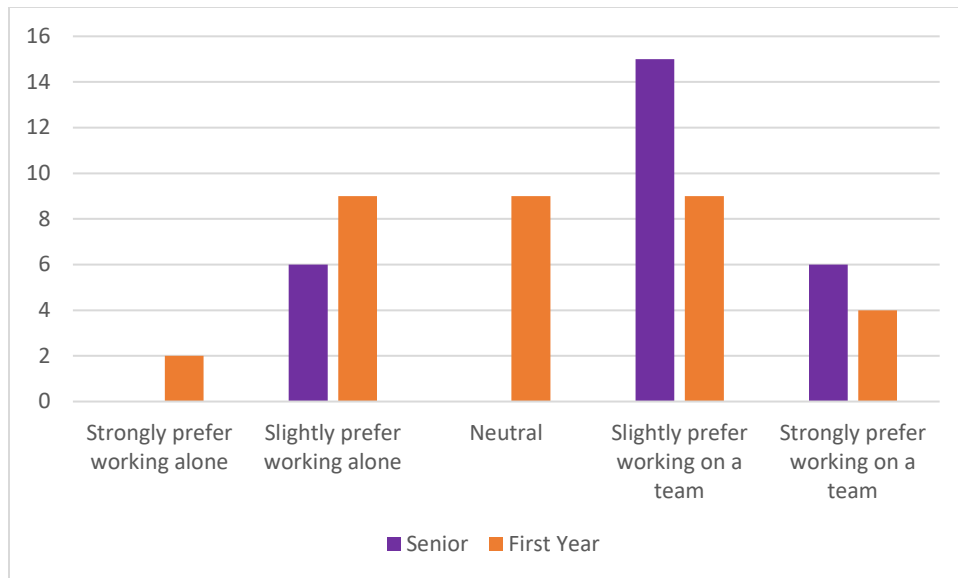
Figure 4: Student preferences as members within a team (Aggregate results from Spring 2023, Fall 2023)

From the games scoring sheets, students ranked themselves as staying true to their character. In EDSGN 100, students had some difficulty understanding how to calculate the individual component of the scoring sheet, and gave numbers that were not 0, 5, or 10, indicating that they were either giving partial credit, or not paying attention to the scoring rules. Some students also gave themselves points if they voted with their initial bias, even if their initial bias did not win the majority vote or gave everyone the full points. For the first round 7 teams reached a partial majority, 3 games had a unanimous decision, and 3 had zero consensus. In the second round 7 teams reached a partial majority, 2 had a unanimous decision, and 4 had zero consensus.

Discussion

Teamwork is an essential component of engineering due to the complex and multidisciplinary nature of the field. Engineering projects typically involve problem-solving and critical thinking, and the unique skills and perspectives of each team member are necessary to arrive at effective solutions. A successful team can lead to a more enjoyable and fulfilling work environment. When team members work together towards a common goal, they can learn from one another, share ideas, and support each other through challenges. This can help foster a sense of camaraderie and create a positive work culture.

While this game serves as an entertaining ice breaker for new teams, and a way to highlight constructive criticism, the game is also a useful tool at describing key moments in the design process. Although the game is extremely simplified in how the design process is explored, it can be used later in the semester as an example of why different techniques are needed. For example, during concept generation discussions in class, this exercise is brought up to show the need for quantity of ideas rather than simply going for the first option. The method of "no-judgement" during concept generation is continued to be upheld as a policy throughout the class. During concept selection these arguments and initial biases are used as justification for objective tools and methods used to limit bias and focus on customer needs.

The primary goal of the game is to help students as they navigate the challenges of teamwork. In the game, the players select ideas not based on the quality of the work but based on their own hidden agendas. However, this sets the practice of separating the idea from the creator and allows the designer to practice removing a sense of ownership and seeing it more as a part of a larger project. More importantly, this game might start to allow students to develop more empathy for their teammates. A student might realize how challenging it is to have only one person play the coach and start to ask others for their opinion more often. An extroverted student might be given the "wallflower" card and realize that a person who is less comfortable speaking up may still have ideas that they wish to share. Additionally, although students may favor ideas during a project due to their own biases, as in the game, they are encouraged to listen to others and change their minds when working with a team.

In future semesters the author plans to have the boardgame utilized in some sections of EDSGN 100, while only using a standard lesson on teaming in others. This will allow a comparison on the effectiveness of the boardgame in terms of how they write their team contract, and how they feel they performed as a team.

Conclusion

This paper provides an overview of survey results from FYE and Capstone Engineering students who participated in a brainstorming simulation game. Students generally agreed that the simulation game was easy to play, an enjoyable use of class time, and beneficial toward helping them identify which behaviors they might like to have featured on their team. Students placed a strong emphasis on including "Coach" and "Chipper" behaviors, likely because those personalities encouraged equal contributions from all team members, leading to a more productive team experience with a balanced workload. Oppositely, students opted to exclude personalities that may be negative or less contributing toward the balanced workload of the team. Future research will explore whether these self-realizations early in the team formation led to students adjusting their attitudes and participation levels within the team dynamics.

First Year Engineering students showed a slight preference toward working alone, while Senior students showed a preference for working on a team. It is likely that FYE students were placed on imbalanced teams during their high school years, which impaired their opinions of working on teams. Senior engineering students will have more recent teaming experiences partnering with fellow engineering students, potentially leading to more evenly distributed workloads and balanced teams. Future studies will follow the opinions of Engineering students from FYE to Senior year to explore how their opinions of teamwork change and develop through their engineering curriculum.

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Appendix A: Rules of the Game

Teaming Tribulations

Objective: Agree on a design as a team, despite your difference of personalities and opinions

Materials:

- Pad of paper (sticky notes or index cards)
- Initial Bias Cards (Green)
- Personal Identity Cards (Red)
- 6-sided die
- Design Prompt cards (yellow, may not be included in student decks)
- Grading Sheet

In this game you will simulate the concept generation and concept selection component of the engineering design process. During your engineering design class, you will learn several methods to ensure that your concept selection is as objective as possible, while limiting any personal biases. Here, you will instead rely solely on a personal bias and will debate based on an assigned personality type.

Game Procedure:

Part 1: Concept Generation:

In this section you will draw a design based off a prompt. No worries if you don't feel inspired for a brilliant design; you will find out that how it is judged has nothing to do with what you've written down.

1. On a note card, write your player/design number (1-5)
2. Draw a design based off your prompt, you will have 2 minutes
3. Name your design, and share your design with your team: no judgements, just description

Part 2: Secret Judgement:

Identify what drawing you like the most and find out your personality. Although as engineers we'd like to imagine we are completely objective when selecting the "best" design, there is often other factors at play. (Note: Every card is kept secret until the end of the game.)

1. Personality Card: This card will determine *how* you debate with your teammates
2. Initial Bias Card: This card says which design you initially like the best.
3. Roll a die until you find out what you need to know. (This is needed for some cards, you can ignore the result of the die if you don't need to know it.)

Part 3: Debate

Your team has 4 minutes to debatewhich design is the best. At the end you must vote on the "best" design. While you may get points for sticking with your initial bias, you may also doom the group project to non-consensus. Reminder: Don't take anything too personally, people are arguing and are not behaving as themselves.

- You have 4 minutes to discuss the designs while staying true to your personality

- You will get a warning at two minutes
- At the end of the round everyone has to put a hand in the air and, when the game leader says "vote", point to a design of their choice

Part 4: Peer Review and Presentations

You will be graded based on if your team reached consensus, if you stayed true to your personality, and if the team voted for your initial bias.

1.   On your score sheet, mark if your team had a unanimous decision,

2.   Share your secret personality and initial bias cards. Give a check for each Initial Bias met by the winner and for each personality card that players were true to.

3.   You will learn the scoring method from the game leader.

Example Scoring Sheet

Scoring Sheet Example: The team voted for Player 3's design with majority vote. Player 3 did not stay true to personality but everyone else did. X's added for each bias or personality card not met, ✔'s for each card met.

Player	Name	Personality Card	Initial Bias	Points Scored
1	xxxxx	Coach ✔	Design 2 ✖	
2	yyyyy	Wallflower ✖	Even number ✖	
3	zzzzz	Chipper ✔	Your design ✔	
4	jjjjjjj	Slacker ✔	Any design but your own ✔	
5	kkkkk	Gloom and Doom ✔	Design 3 ✔	

Voting:

Results	Score
Unanimous (All players vote for same design), Majority vote, or Zero consensus	
Total Score (Player points + Team score)	
Grade	

Appendix B: Survey Questions for the start and end of the class project

1. Did you complete the teaming boardgame in recitation (if not, skip to question 11)
2. What was your big take away from this game? What did you learn or discover? *Note this question was only asked starting Fall 2023 onward*
3. How might you apply from what you learned from the game to your design project this semester? *Note this question was only asked starting Fall 2023 onward*
4. What personality cards were you assigned for the recitation game activity?
5. Which personality cards do you think were easier or harder to play in general? Which would be more challenging for you to play? Why?
6. If you could build your ideal team for a school project, which personality types would you include on your team?
7. If you could build your ideal team for a school project, which personality types would you exclude on your team?
8. How did you find the teaming boardgame in terms of identifying traits you like in a team?
9. Rate the helpfulness of the teaming boardgame in identifying an ideal project team.
   Not helpful at all   Not very helpful   Neutral   Helpful   Very helpful
10. How did you find the teaming boardgame in terms of enjoyment
    Not Enjoyable at all   Not Very Enjoyable   Neutral   Enjoyable   Very Enjoyable
11. In general, what aspects of working on a team (especially for a class project) considering a team project) do you like the best?
12. In general, what aspects of working on a team (especially for a class project) do you find most challenging? List your top #3 challenges for working on a team.
13. What is your preference when working on a school project?
    Strongly prefer working alone   Slightly prefer working alone   Neutral
                                        Slightly prefer teamwork   Strongly prefer teamwork

Appendix C: In Class Scoring Sheets

Player	Name	Personality Card	Initial Bias	Points Scored
1				
2				
3				
4				
5				

Voting:

Results	Score
☐ Unanimous (All players vote for same design) ☐ Majority vote ☐ Zero consensus	
Total Score (Player points + Team score)	