

Gamification of Student Advising: Helping Students Decide Between Civil and Construction Engineering

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Abstract

College students with an interest in the built environment often struggle to understand the differences between civil and construction engineering. Lack of proper understanding of the differences between the two majors may cause inappropriate major selection by first-year college students. To enable informed major selection by first-year civil/construction engineering students, the authors have developed a game that simulates the work environment and the major decision points faced by construction engineers. A pre-post survey analysis compares the students' understanding of construction engineering before and after they played a working prototype of the game. The survey results quantify game effectiveness in attracting students toward the construction engineering major. The results show the great potential of the game to improve student understanding of the differences between civil and construction engineering.

Keywords

Gamification, Civil Engineering, Construction Engineering

Introduction

The Citadel requires incoming freshman in the civil engineering and construction engineering degree programs to enroll in a one credit hour "Introduction to Civil Engineering" course. One of the course objectives is to familiarize students with the sub-disciplines of civil engineering including a module in construction engineering. To demonstrate a unique aspect of construction engineering, the risks and rewards of contract types and high-performance building certifications were gamified. Students competed in teams of "owners", "design engineers", and "construction engineers" for a successful project. This paper contains the work in progress for this game, to include the "owner", "design engineer", and "construction engineer" role descriptions provided to the students.

Owner Role Description

As the owner, student teams determine the project's required functionality, durability, and sustainability requirements. They also provide the funding and will benefit from a project that is delivered on time. The owners' role is to build a successful team, by hiring the best Construction Engineer and Design Engineer for the project. The owner team creates a project scope for the design engineer to create the design; the resulting design allows the construction engineer to build the project. The owner must work with the design and construction engineering teams to resolve any issues that arise during construction, and provide incentives and penalties for a project that does not meet the scope requirements or timeline. Owners aim to receive a project with greater

value than the cost of design and construction. The owner team percentage profit is the value of the delivered project minus the actual project cost divided by the actual project cost.

Design Engineer Role Description

The design engineering team provides the design for a project that meets the owner’s project scope with sufficient accuracy and completeness for the construction engineering team to build the project successfully. The owner’s project scope includes various design requirements, such as the project’s functionality, durability, and sustainability requirements. The design team will work with the construction engineering team to ensure any issues that arise during construction can be resolved to the satisfaction of the owner, as well as other team members. The design engineering team aims to negotiate and execute a contract for the design of the project for the greatest percent profit possible.

Construction Engineer Role Description

The construction engineering team must construct a project that follows the design engineering team’s drawings and specifications and meet the owner’s project scope. The owner’s project scope includes various requirements, such as the project’s functionality, durability, and sustainability requirements. The construction engineering team will work with the design engineering team and resolve any issues that arise during construction to the satisfaction of the owner. The construction engineering team aims to negotiate and execute a contract for the construction of the project for the greatest percent profit possible.

Negotiation

Each team must negotiate team mark-up (profit) for their cost in construction of the building. This markup will be based upon what the probability of success at each of the different levels of certification, and the risk in each of the project delivery types. Engineering teams bid and negotiate with the owner teams to secure a contract including the final agreed upon certification level, project delivery type, and contract terms. The probability cost tables (Tables 1-3) show the probable cost to each team for each certification level.

Table 1. Cost of design for the design engineering teams

LEED Certification	Probability of Cost	Cost (Million Dollars)
Certified	17% (roll 6)	5
	66% (roll 2-5)	10
	17% (roll 1)	15
Silver	17% (roll 6)	5
	33% (roll 4,5)	10
	50% (roll 1-3)	15
Gold	17% (roll 6)	10
	66% (roll 2-5)	15
	17% (roll 1)	20
Platinum	17% (roll 6)	10
	33% (roll 4,5)	15
	50% (roll 1-3)	20

Table 2. Cost of construction for the construction engineering teams

LEED Certification	Probability of Cost	Cost (Million Dollars)
Certified	17% (roll 6)	90
	66% (roll 2-5)	100
	17% (roll 1)	110
Silver	17% (roll 6)	90
	50% (roll 3-5)	100
	33% (roll 1,2)	110
Gold	17% (roll 6)	90
	17% (roll 5)	100
	50% (roll 2-4)	110
	17% (roll 1)	120
Platinum	17% (roll 6)	90
	17% (roll 5)	100
	17% (roll 4)	110
	33% (roll 2,3)	120
	17% (roll 1)	130

Table 3. Value of delivered project for the owner teams

LEED Certification	Probability of Cost	Value (Million Dollars)
Certified	33% (roll 5,6)	120
	33% (roll 3,4)	130
	33% (roll 1,2)	140
Silver	17% (roll 6)	120
	66% (roll 2-5)	130
	17% (roll 1)	140
Gold	33% (roll 5,6)	130
	33% (roll 3,4)	140
	33% (roll 1,2)	150
Platinum	17% (roll 6)	150
	66% (roll 2-5)	160
	17% (roll 1)	170

Resolution

Once contracts have been awarded by the owner teams to the design and construction engineering teams, each project is evaluated based on the probability in Tables 1-3. Each team rolls a single six-sided die. Based on the LEED Certification and the die roll the engineering teams determine the cost and the owner determines his delivered project value. Each engineering team then determines their invoice to the owner as well as their profit. The owner compares his cost (the invoices from the engineering team) to his value to determine his profit. The team with the largest percent profit wins, while any teams with negative profit show a loss and go out of business.

Conclusion

This game allows students to see and appreciate some element of the risk and reward associated with contract types and high-performance building certifications, scenarios construction engineers will face in their career. As the work proceeds, the game will be refined, and student responses will be gathered and processed.

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Timothy Wood is an Assistant Professor of Civil and Environmental Engineering at The Citadel. He acquired a Bachelor's in Engineering Physics Summa Cum Laude with Honors followed by Civil Engineering Master's and Doctoral degrees from Texas Tech University. His technical research focuses on the intersection of soil-structure interaction and structural/geotechnical data. He encourages students pushing them toward self-directed learning through reading and inspiring enthusiasm for the fields of structural and geotechnical engineering. He aims to recover the benefits of classical-model, literature-based learning in civil engineering education.