



Design and Evaluation of a Competition-Based Instructional Model in Structural Engineering

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KEYWORDS

ABSTRACT

Design competitions are increasingly used in engineering education to bridge the gap between theoretical knowledge and practical application. They provide students with opportunities to engage in real-world problem-solving, teamwork, innovation, and project management. This study examines the lessons learned from a structural engineering design competition focused on the development of a pedestrian walkway at the Université de Sherbrooke.

The research analyzes the educational impact of the competition, evaluates student performance, and identifies strengths and challenges in the learning process. It highlights how experiential learning, collaborative work, and competitive environments contribute to skill development. The study also proposes improvements for future competitions to enhance learning outcomes, align with industry practices, and support curriculum development.

INTRODUCTION

Structural engineering education requires a balance between theoretical knowledge and practical experience. Traditional classroom teaching often lacks opportunities for students to apply concepts to real-world problems. Design competitions address this gap by providing hands-on learning experiences.

In this context, given the absence of existing studies related to road geometric design, the objective of this project is to enhance students' comprehension of geometric road design through the creation of physical models of the road and board games. Road geometric

design is crucial for safety and efficiency, as it helps reduce crashes by considering factors like curve radius and sight distance, and ensures smooth traffic flow through proper lane capacity and intersection design. Although initially costly, it proves cost-effective over time by reducing fuel consumption, vehicle wear, and maintenance needs. This study addresses the research gap in innovative educational approaches to geometric road design by employing physical prototypes and board games. Incorporating active learning methods like challenge-based learning and prototyping, it aims to enhance student engagement, comprehension, and

retention of complex concepts, thereby preparing future civil engineers with practical, hands-on experience. The study's approach utilizes STEM methodologies to create an inclusive learning environment, emphasizing safety, efficiency, and cost-effectiveness in road design. This method bridges the gap between theory and practice while fostering creativity, teamwork, and iterative learning among students. This paper addresses the significance of embedding sustainability in engineering education by specifically investigating the role of pedagogical approaches in fostering transformative learning experiences among students. It considers changing roles for engineers, emerging demands from industry, and concerns over ongoing global issues that create an important case for change. Through theoretical perspectives and examples of practice, the paper presents ways sustainability gets woven into engineering programs, curricular, pedagogy and how these efforts contribute to shifts in student perspectives. The ultimate goal is to contribute to raising the next generation of engineers who possess the knowledge, skills, and ethical foundation to tackle the wicked problems of the 21st century, and contribute to a more sustainable future.

LITERATURE SURVEY

Experiential Learning in Engineering

- Findings: Improves understanding and retention
- Limitation: Resource-intensive

Design Competitions in Education

- Findings: Enhance creativity and innovation
- Limitation: Competitive pressure

Project-Based Learning

- Findings: Encourages teamwork and problem-solving
- Limitation: Time constraints

Structural Engineering Education

- Findings: Practical exposure is essential
- Limitation: Limited opportunities

Industry-Academia Gap

- Findings: Competitions help bridge the gap

Educational Studies

- Common Findings:
 - o Active learning improves outcomes
 - o Collaboration enhances learning
 - o Real-world projects increase engagement

EXISTING SYSTEM

In the existing system, engineering education—particularly in areas such as structural design—is primarily delivered through traditional teaching methods that emphasize theoretical instruction and standardized problem-solving. Students typically learn through lectures, textbook exercises, and predefined laboratory experiments, where the focus is on understanding established formulas, design codes, and analytical techniques. While this approach builds foundational knowledge, it often lacks opportunities for creativity, innovation, and real-world application. Structural design projects assigned to students are usually limited in scope, highly guided, and evaluated based on correctness rather than originality or efficiency. There is minimal exposure to open-ended challenges where multiple solutions are possible, and constraints mimic real engineering scenarios. Additionally, teamwork and collaboration are present but not deeply emphasized, often resulting in unequal participation and limited peer learning. The absence of competitive elements reduces motivation for students to push beyond minimum requirements, and there is little incentive to optimize designs for performance, cost, or sustainability. Feedback mechanisms are typically instructor-driven and summative, provided only after project completion, which restricts opportunities for iterative improvement. Furthermore, industry involvement is minimal, and students rarely gain insights into how engineering competitions or real-world design challenges operate. As a result, graduates may possess strong theoretical knowledge but often lack practical problem-solving skills, innovation capabilities, and the ability to perform under realistic constraints and competitive environments.

DRAWBACKS OF EXISTING SYSTEM

1. Lack of real-world experience
2. Limited student engagement
3. Poor development of practical skills
4. Lack of teamwork opportunities
5. Limited creativity and innovation
6. Gap between theory and practice
7. Insufficient exposure to project management
8. Limited problem-solving experience
9. Lack of interdisciplinary learning
10. Poor industry readiness

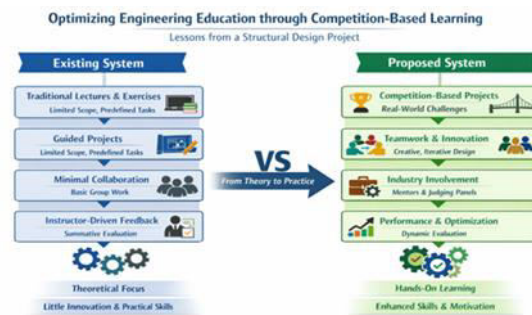
PROPOSED SYSTEM

The proposed system introduces a dynamic, competition-based learning framework that enhances engineering education by integrating real-world challenges, teamwork, and performance-driven outcomes into the learning process. In this approach, structural design projects are restructured as competitive events where students or teams are tasked with solving open-ended problems under defined constraints such as material limits, cost considerations, load requirements, and sustainability goals. This framework encourages students to think critically, innovate, and optimize their designs to achieve the best possible performance. Competition-based learning fosters a high level of engagement and motivation, as students strive to outperform peers while developing practical engineering solutions. The system incorporates iterative design processes, where students receive continuous feedback from instructors, peers, and industry experts, allowing them to refine and improve their designs over multiple stages. Advanced tools such as simulation software, structural analysis programs, and digital modeling platforms are integrated to support data-driven decision-making and realistic testing of designs. Collaboration is strengthened through structured team roles and responsibilities, ensuring balanced participation and effective communication. The framework also emphasizes experiential learning by simulating real-world conditions, including deadlines, resource constraints, and evaluation criteria similar to professional engineering competitions. Assessment is comprehensive, considering not only technical accuracy but also innovation, efficiency, teamwork, and presentation skills. Additionally, industry involvement is encouraged through mentorship, judging panels, and sponsorship of competitions, providing students with exposure to professional standards and expectations. Overall, the proposed system transforms engineering education into an interactive, practical, and performance-oriented experience, equipping students with the skills, confidence, and adaptability required to succeed in modern engineering practice.

ADVANTAGES OF PROPOSED SYSTEM

- Enhanced practical skills
- Improved teamwork and communication
- Increased student engagement

- Development of critical thinking
- Better understanding of engineering concepts
- Exposure to real-world challenges
- Improved employability
- Encouragement of innovation



METHODOLOGIES

Research Design

- Case study of design competition

Data Collection

- Student feedback
- Performance evaluation
- Faculty observations

Tools and Techniques

- Structural analysis software
- Design tools
- Survey methods

Implementation Steps

1. Define competition objectives
2. Form student teams
3. Assign design tasks
4. Conduct evaluation
5. Analyze results

Evaluation Metrics

- Design quality
- Innovation
- Team performance
- Presentation skills

CONCLUSION

Design competitions play a significant role in enhancing engineering education by providing hands-on learning experiences. The case of the pedestrian walkway at the Université de Sherbrooke demonstrates the effectiveness of such competitions in improving technical and soft skills among students.

The proposed framework integrates competition-based learning into the curriculum, addressing the limitations of traditional teaching methods. By adopting this

approach, institutions can better prepare students for professional practice.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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