Establishing the Structural Learning Lab: Enhancing Engagement and Understanding in Civil Engineering Education

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CONTEXT & OBJECTIVES

Context:
The Structural Learning Lab was established to close educational gaps in civil engineering by transforming an underutilized storage room into an interactive teaching space. The lab houses physical models that support active learning, especially for students who struggle with abstract structural concepts.

Problem:
Before this project was implemented, rooms within the Structural Lab at CSUS were cluttered and underutilized. Physical models were difficult to access, instructional manuals were outdated, and no inventory system was in place. As a result, faculty were often unaware of the available resources, and students missed valuable opportunities for hands-on, visual learning of complex structural concepts, limiting the effectiveness of active learning, especially in civil engineering courses.

Objectives:
This project aimed to create a dynamic and inclusive learning space that improves teaching and learning in structural engineering. It also sought to reduce equity gaps by making hands-on tools more accessible to women, first-generation students, and underrepresented groups in STEM.

The Structural Learning Lab project was designed with the following specific objectives:

- Organize and inventory educational models
- Update manuals for effective classroom use
- Develop new physical models to support visual-spatial learning
- Enhance student engagement and comprehension
- Promote inclusive education through hands-on tools
- Assess impact with surveys and performance data
- Share results through conferences and faculty outreach.

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METHODOLOGY

1. Resource Reorganization
Created a digital inventory system and restructured the lab space to make educational models accessible and easy to use, encouraging more hands-on engagement.

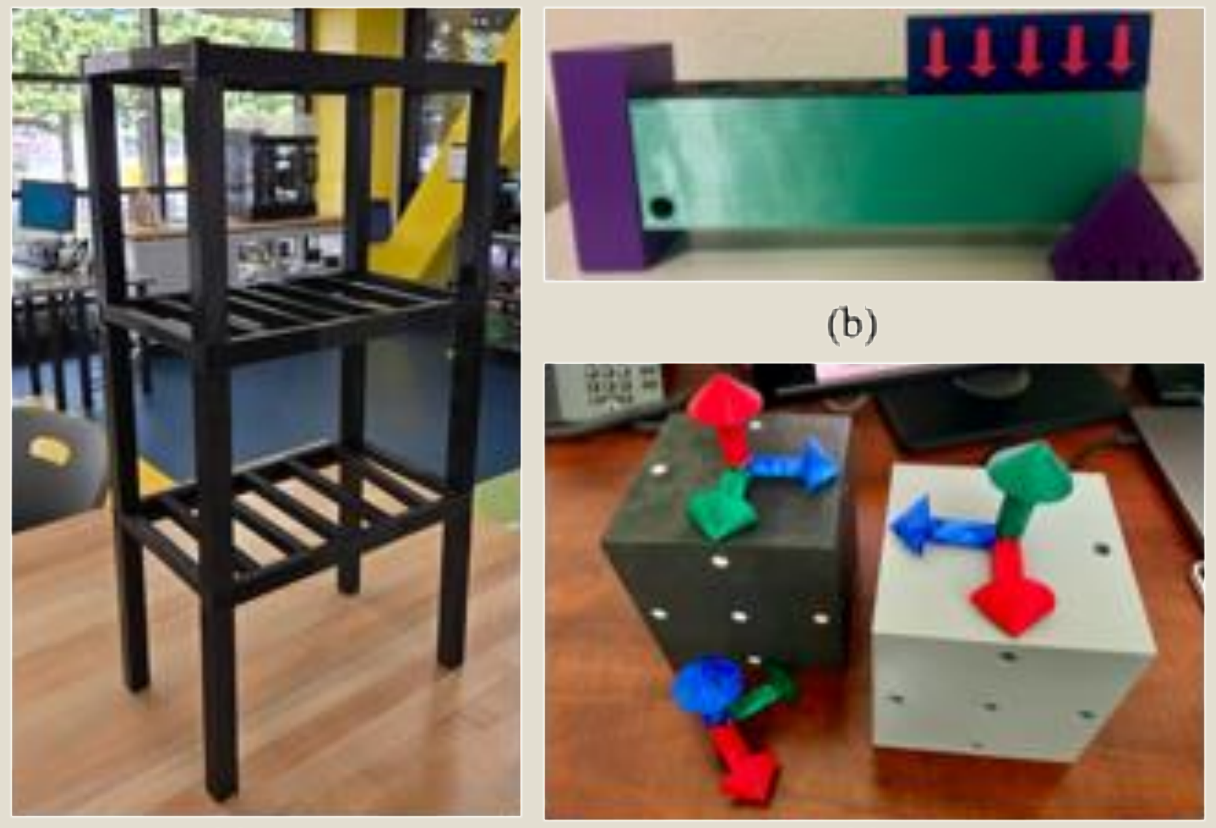
(a)

(b)

Figure 1. Progressive reorganization of the space: (a) initial state of the room and disorganized and unused materials; and (b) final organized layout.

2. Manual Updates
Revised and pilot-tested instructional manuals with students. Feedback led to clearer setup guides and practical examples. Faculty review is planned for continued refinement.

3. Development of Physical Models
To support hands-on learning, three innovative physical models were developed using 3D printing: the Load Path Explorer, the Flex Frame, and the Stress Cube.



(a) (b) (c)

Figure 2. Developed physical models: (a) Load Path Explorer; (b) Flex Frame; and (c) Stress Cube.

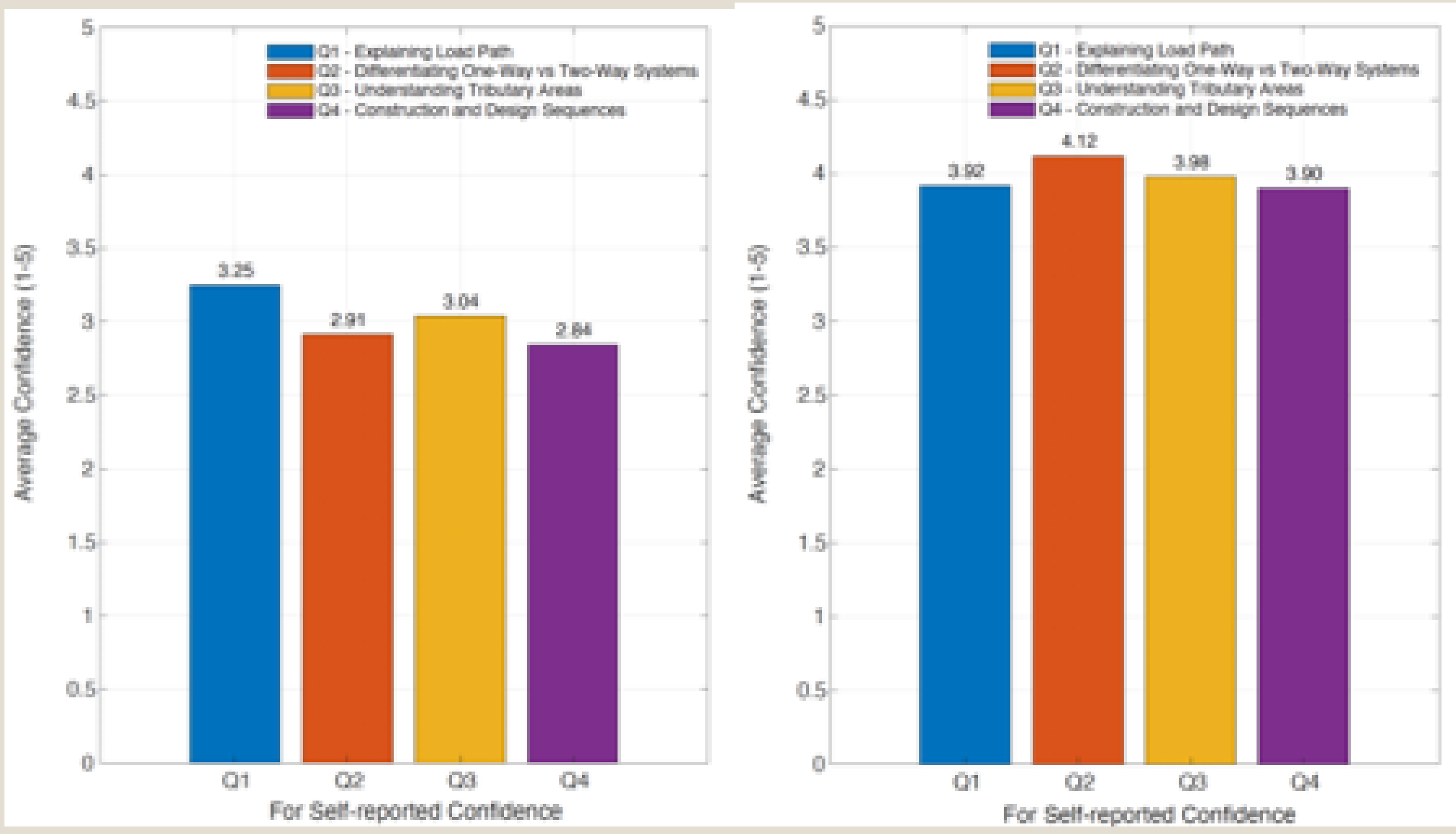
IMPLEMENTATION

4. Evaluation and Engagement
Implemented student surveys and classroom demos to assess learning gains and engagement. Future evaluations will expand to additional models and courses.

Figure 3. CE160 students participating in a hands-on demo activity using the Load Path Explorer Model.

RESULTS & CONCLUSION

Pre/Post Survey Highlights (CE160 Spring 2025):
Confidence improved significantly in load path understanding, tributary areas, and system classification.



(a) (b)

Figure 4. Mean student self-confidence ratings for structural reasoning concepts using the Load Path Explorer model: (a) pre-implementation survey and (b) post-implementation survey. Confidence scale: 1 = Not confident, 5 = Very confident.

ACKNOWLEDGMENT

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