A Successful Story of Applying a Variety of Representational Tools in College STEM Education [1]

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**Background**

The STEM Education Center is working with faculty in the Electrical and Computer Engineering Department to adapt the Lesh Translational Model, though specifically designed for elementary mathematics teachers in an electrical engineering classroom. The current study reports a successful story of using a variety of representational tools for instruction.

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**Purpose**

- To expand on innovative practices for “flipping lectures” into recitations;
- To prepare students to face real world challenges focusing on co-development of cognitive and metacognitive knowledge and skills.

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**Research Design and Method**

*Applying Design-Based-Research (DBR) to intertwine the three goals of research, design, and pedagogical practices in this study.*

**Data collection from multiple courses including:**
- two on-line surveys at the beginning and the end of the semester
- students’ exam papers and other worksheets

**Data analyses:**
- Developing a framework to evaluate the co-development
- Developing scoring rubrics to assess representational fluency

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**Results and Findings**

**Fig. 1 (L) Engineering Practice Cycles; (R) Lesh Translational Model.**

**Research Questions**

1. Is content knowledge co-developed with problem-solving skills and metacognitive functions under problem-centered learning?
2. Does the distribution of content knowledge among a variety of representational modes facilitate such co-development?
3. What are the implications in STEM teaching and learning for such development?

**Reference:**


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**Conclusion and Implications**

**Multiple representations embedded in instructions**
- promote teaching and learning that facilitates the co-development of content knowledge, problem solving skills, and metacognitive knowledge;
- strengthen the association of instructional objectives for lectures and recitations;
- require that problems are framed in ways to engage students in deep discussions during lecture periods and provide students with resources and insights in problem solving during recitations;
- offer opportunities for formative assessment allowing instructors to understand what and how students learn.

**Findings (Figs 2&3)**

- Students improved abilities of using multiple representational tools;
- The Level of improvement was positively correlated with course performance.

**Fig. 2 Percentage of the student groups that shifted usages of representational modes.**

**Fig. 3 Improved translational fluency (upper: test 1; lower: final).**

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