Combining hands-on and virtual experiments for enhancing fluid mechanics teaching: A design-based research study
Ronald R. Gutierrez, Frank Escusa, Joseph A. Lyon, Alejandra J. Magana, Jose H. Cabrera, Richard Pehovaz, Oscar Link, German Rivillas-Ospina, Guillermo J. Acuña, Julio M. Kuroiwa, Monica X. Guzman, Francisco G. Latosinski
Computer Applications in Engineering Education
https://doi.org/10.1002/cae.22551

Computer-assisted techniques and design-based research to improve engineering instruction in developing countries

What is it about?

Despite compelling evidence on computer-assisted techniques effectiveness in engineering teaching in developed countries, it is safe to state that very few universities in developing nations have applied them before the coronavirus pandemic. This contribution reports a large educational intervention that combines virtual and hands-on laboratory experiments and flipped classroom learning practices on an undergraduate Fluid Mechanics course, which provides the fundamental basis to several engineering disciplines (e.g., civil, chemical, mechanical, environmental, mining engineering, etc.) A large portion of the produced educational resources are provided as freely accessible material that follows the UNESCO standards.

Why is it important?

The intervention in question is reported via well stablished technical frames used in engineering education research (e.g., design-based research, conjecture mapping, fidelity of procedure) as shown in Figure 1 below. Thus, it can be applied to a wide range of engineering-related courses for both practical (e.g., design-enact educational interventions) and scientific purposes such as conducting research on teaching-learning processes in engineering instruction. To the best of our knowledge, this contribution pioneers engineering education research in several developing economies.

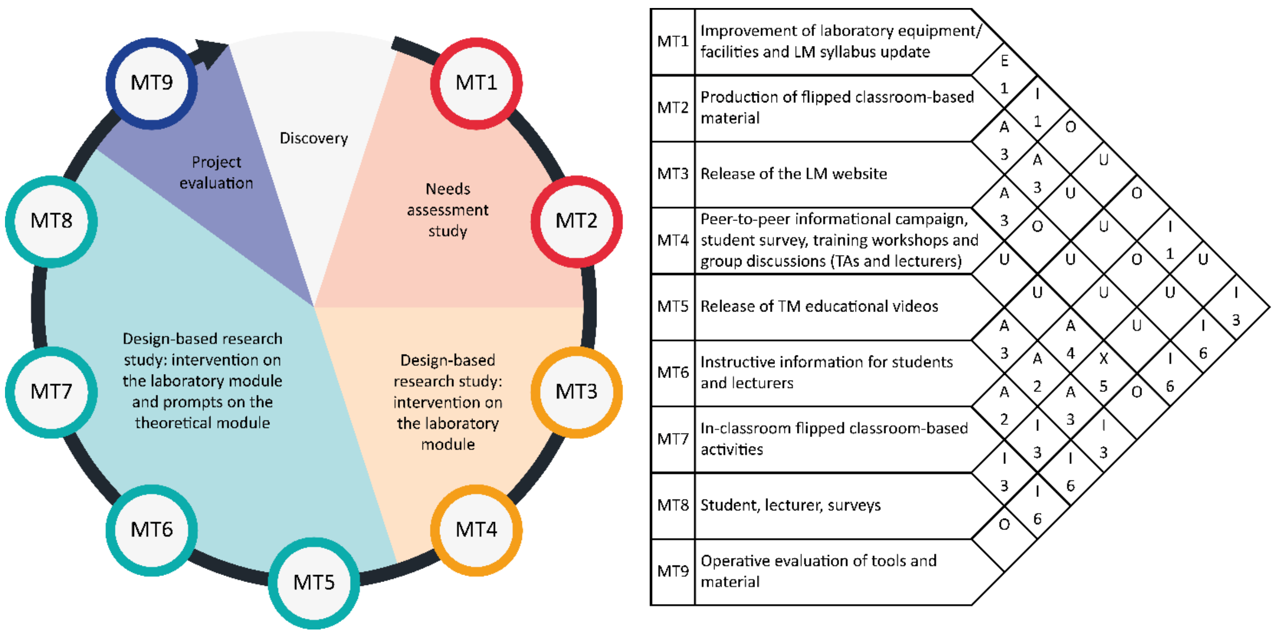

Figure 1: Left: design stages and main tasks (MT) associated to the mediating processes at each stage; right: theoretical conjectures that link the mediating processes to the design outcomes. The theoretical conjectures are categorized as absolutely essential (A), essential (E), important (I), ordinary importance (O), unimportant (U), and undesirable (X). Likewise, the categorization is justified for the following controls: university policies (1), technical requirement of the learning model (2), logical process of the educational intervention (3), potential correlation (4), bias avoidance (5), and avoidance of process malfunctioning under limited supervision (6). TM=theoretical module, LM=laboratory module, TAs=teaching assistants.

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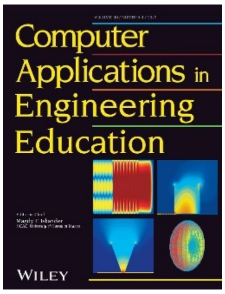
Where the educational resources can be accessed from?

The produced educational resources represent freely accessible material validated through well stablished engineering teaching research technical frames. They follow the UNESCO standards and can be accessed from the link below:

https://sourceforge.net/projects/fluidmecvirtualexperiments/files/

Perspectives

Under the light of our results, we highlight the need to collaboratively upscale the reported educational intervention by means of the formation of engineering education research groups that could build, for instance, common-pool Fluid Mechanics educational resources.



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