# Learning Engineering: Courseware Instrumentation and Learning Analytics (LECILA)

Special track in the 13th International Conference on Mobile, Hybrid, and On-line Learning (eLmL)
https://www.iaria.org/conferences2021/eLmL21.html
July 18, 2021 to July 22, 2021 - Nice, France

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**ABSTRACT**
This paper summarizes the three papers in the session of the eLmL special track, "Learning Engineering: Courseware Instrumentation and Learning Analytics." The research presented in this track highlight key research insights in the domain of learning engineering:

- Replication of key research in online course design methodology.
- A case study in the ethical practice within the domain.
- A comparison of educational technologies.

All three offer new challenges to lasting ideas in education, necessary toward furthering learning engineering as a discipline and a practice.

**KEYWORDS**
Learning engineering, learning design, online learning, education, learning science, e-learning, open learning, mobile learning, learning analytics, ed tech, learning platform, education games, gamification, courseware.

## I. INTRODUCTION

Learning Engineering is defined by the IEEE Standards Association's Industry Connections Industry Consortium on Learning Engineering (ICICLE) as, "A process and a practice that applies the learning sciences using human-centered and engineering design methodologies and iterative data-informed decision making to support learners and their learning [1]." Herbert A. Simon, the late Nobel and Turing Award laureate and Carnegie Mellon University Professor coined the term "Learning Engineers" in his plea to college presidents to think more seriously about how learning experiences are designed and measured [2]. Learning Engineers, and therefore Learning Engineering as a discipline, is meant to take what is known from the learning sciences, apply those findings into purposefully-designed learning experiences, instrument those experiences to measure learning outcome mastery, and incorporate any new insights to further understand where particular interventions are best-suited. This cycle of iterative data collection and improvement will lead to better experiences for all learners.

This approach education with rigor comes with costs. The LE process requires a focus and investment in learning environments as lasting yet improving over time. Incorporation of significant insights, like "learning by doing [3]" require thoughtful planning and hard work from a variety of roles. The ability to collect learner data and perform analysis with ease leads to concerns about privacy. At the same time, new technologies to support learning in various ways are constantly entering the domain, with expectations of use and effectiveness. This track nicely illustrates research findings across these topic areas, touching on key ideas in learning engineering, and sets up the field to tackle future challenges.

## II. SUBMISSIONS

The first paper, "The Doer Effect: Replicating Findings that Doing Causes Learning [3]," successfully accomplishes the replication of a key study, particularly in e-learning. The idea that learning gains can be accomplished more effectively and efficiently through the addition of "Learn by Doing" activities in a course was first established by Ken Koedinger et al. in 2015 [4]. Koedinger also went on to establish this effect as a causal relationship [5]. Van Campenhout et al. first established the definition of learning by doing in courseware as, "a method of engaging the learner in the learning process by providing formative practice at frequent intervals [3]". From there, they chose to study the impact of this approach in established courseware, delivered this courseware to a large population of students (3,513), and captured measures of reading versus active use of formative practice activities. The results were clear, successfully replicating the results of the Koedinger et al. studies. This type of study replication is crucial toward establishing learning engineering as an applied learning science.

The second paper, "A Learning Engineering Ethical Framework: Keeping the Learner Centered [6]" covers another topic for this emerging profession of learning engineering and provides an ethical framework from which to make learner-centered design decisions. The author maintains that, "The learning engineer is an advocate for the learner," therefore making this domain an "ethical practice." Van Campenhout does the profession a great service by framing it in this way. With the use of student data being at the heart of the profession, this characterization of learning engineers as ambassadors and protectors of this data is necessary and hopeful.

The third paper, "Advances in Gamification in Education [7]" is on-point as a learning engineering topic. The authors acknowledge that the concept of "gamification" has been around for awhile, but also note the lack of established conclusions from results. Hajari and Lee set out to perform a meta-analysis on the topic leading to some established definitions of gamification, adaptivity in gamification, and discussion of effectiveness of these types of interventions used in educational courseware. Their conclusions are not surprising, but so very important for future considerations and research in the discipline. I would encourage more researchers to follow in their footsteps toward generating more meta-analyses on these types of education topics.

## III. CONCLUSION

The research results presented in this track contribute greatly to the new and growing field of Learning Engineering in various ways: by adding to the growing list of working interventions in education, using data to draw conclusions about best practices, and setting the stage for ethical practice of the profession. These researchers have done a incredible job and I applaud them for their efforts.

## ACKNOWLEDGEMENTS

So much gratitude to the organizers of the conference for their kind encouragement and support all along the way. Special thanks to the reviewers who gave the authors valuable feedback. Thanks to the authors who made this track possible. And to my colleagues at Carnegie Mellon's Simon Initiative, I thank them for their sponsorship.

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