Learning Engineering

Scenario

Promita Hafiz, a professor of computer science at Winters University, specializes in the intersection of computing and cognitive science. In recent years her work has explored how technologies like LMSs, MOOCs, and virtual reality support learning. Through that research, Hafiz has become fascinated by the way that tools and principles from engineering come into play in the development and use of learning technologies. Her investigations have led her to become a proponent of learning engineering, an evolving field that focuses on how engineering methodologies can inform and improve learning technologies and related architectures.

Recognized as a national leader in this area, Hafiz was asked to join a consortium that seeks to clarify what learning engineering is and how it can best contribute to innovations in learning technology. Through the consortium, Hafiz has been collaborating with colleagues from both industry and academia to develop a definition of learning engineering that will help advance this burgeoning field. Based on this work, Hafiz’s thinking has evolved such that she now thinks about learning engineering as both an academic discipline and as a profession that needs to be nurtured and developed. She believes that learning engineers bring invaluable expertise and new perspectives to learning design. She is convinced that learning engineers will continue to play an ever more important role in translating knowledge about cognitive processes into technology-based learning and pedagogy. Hafiz’s recent research has been exploring how the emerging field of learning engineering relates to the more established practice of instructional design. For the time being, she says, we need both roles, although she envisions greater integration of the two functions eventually.

Apart from her work in developing a philosophy and working theories around learning engineering, Hafiz is also focused on what she sees as a growing need for skilled practitioners in the field. To that end, she has developed several courses that seek to train future learning engineers for work in both academia and industry. Student interest in this field has been growing demonstrably, and both current students and potential employers of learning engineers have made many good suggestions for further coursework.

Building on these experiences, Hafiz recently proposed that Winters establish a master’s degree program in learning engineering. After discussions, Hafiz’s colleagues concurred that the time was right to formalize this training, and the program will launch in the fall.

1 What is it?

The term “learning engineering” was coined more than 50 years ago by Herbert A. Simon, an expert on artificial intelligence, and colleagues at Carnegie Mellon University who saw the need to apply technical competencies to learning. Today, Simon’s prescient vision is evident in an emerging manifestation of learning engineering as both a professional practice and an academic discipline. Sitting at the confluence of learning science, learning technology, and instructional design, today’s iteration of learning engineering can be framed as the application of engineering design methodologies in developing learning technologies and infrastructures to support learners and learning. Learning engineering recognizes that the development of new tools and architectures to help advance learning can benefit from engineering expertise. A significant effort to codify learning engineering and support the development of learning engineering is currently underway under the auspices of the IEEE IC Industry Consortium on Learning Engineering (ICICLE). In 2016, a provocative report on online learning from MIT outlined how learning engineers might be trained.

2 How does it work?

Learning engineers combine skills from engineering and systems thinking with knowledge of learning science and theories of human development to design, construct, and deploy new learning technologies and architectures. As one expert suggested recently, learning engineers typically have broad knowledge of engineering processes as well as of learning science, computer science, and data science. In addition to understanding instructional design, artificial intelligence and machine learning, pedagogy, and andragogy, they offer skills in systems and user experience design, product testing, and the development of policies, regulations, and standards. They leverage those skills to create learning experiences, courses, and curricula; define educational competencies and assessment standards; and use research and data to improve teaching and learning. Learning engineers gather requirements and apply technologies, science, and standards to propose, test, and implement solutions, applying engineering processes in the domain of learning. That work spans a spectrum from the micro (developing specific applications) to the macro (developing large-scale digital architectures for learning).
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3 Who’s doing it?
At Carnegie Mellon University, the Simon Initiative is building a learning engineering ecosystem in which faculty can use learning science research to improve their educational practice. As an example of universities increasing their hiring in this growing field, CMU was recently recruiting for a learning engineer to support faculty in developing and incorporating technology-enhanced learning in its Eberly Center for Teaching Excellence and Educational Innovation. Among universities offering academic programs related to learning engineering is the information science and learning technologies doctoral program at the University of Missouri. Relevant master’s programs include one in learning, design, and technology at Stanford University; the Technology, Innovation, and Education (TIE) program at Harvard University; and a program leading to an MSe in learning sciences and technology at the University of Pennsylvania. A new master’s program in learning engineering was recently approved at Boston College.

4 Why is it significant?
As the infrastructures and architectures that support learning evolve and become increasingly more technology dependent, there is a growing role for engineering expertise to support the development of new technologies for learning and to work with instructional designers and faculty to maximize its value. Learning engineers have the skills needed to integrate engineering and systems thinking with learning science in support of better learning technologies and, ultimately, improved learning outcomes. Further, learning engineers can draw on engineering techniques to expand our body of evidence about what works in education. They can apply multidimensional expertise to develop high-quality applications for teaching and learning that are the product of more consistent development processes than many current efforts and that result in applications that are replicable, reliable, and sustainable.

5 What are the downsides?
The new manifestations of learning engineering are evolving, and current definitions of what this field is and does are somewhat amorphous and fluid. More clarity is needed, even at the level of job titles and job descriptions for learning engineers. Because much of this field is charting new territory, integrating it into the academy and the education technology industry may initially create disruption and confusion. Developers and academics alike will need to be educated about the value that learning engineers can add and will need to learn how to best work with such professionals. It will take time to fully recognize the value of learning engineering, inculcate it into practice, scale it, and integrate it so that its potential can be realized.

6 Where is it going?
Learning engineering is likely to continue to develop as an academic discipline, as demand for skilled professionals builds. With that expansion will come more and perhaps deeper research into the meaning, definitions, and practice of learning engineering. More studies will yield evidence about how it works and works best, further demonstrating its value for enhancing teaching and learning. As the field expands, it will develop more robust policies, regulations, and standards. Professionals in the field will define effective practice for learning engineers, perhaps in tandem with the development of professional societies and opportunities for professional development.

7 What are the implications for teaching and learning?
Just as civil engineering, mechanical engineering, and electrical engineering have led to better practices across society, learning engineering can combine the power and discipline of both engineering and learning science in the development of better, more reliable, and more effective technology tools for instructors and learners. In contrast to current practice, where development of learning technology can be ad hoc and is often concentrated with vendors, learning engineering has the potential to help higher education take more direct control of the development and deployment of instructional technology. Indeed, progress in developing the next generation digital learning environment (NGDLE) will likely require the skills that learning engineers offer. To that end, learning engineering provides disciplined pathways for developing, testing, and implementing reliable, evidence-based, scalable, high-quality solutions. In these ways, learning engineers provide architectures and techniques that can help us develop new and better tools to apply what we are learning about learning, cognition, and human development—in essence, advancing progress in applied learning sciences in new and potentially transformative ways.