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IEEE IC INDUSTRY CONSORTIUM ON LEARNING ENGINEERING

Proceedings of the 2019 Conference on Learning Engineering

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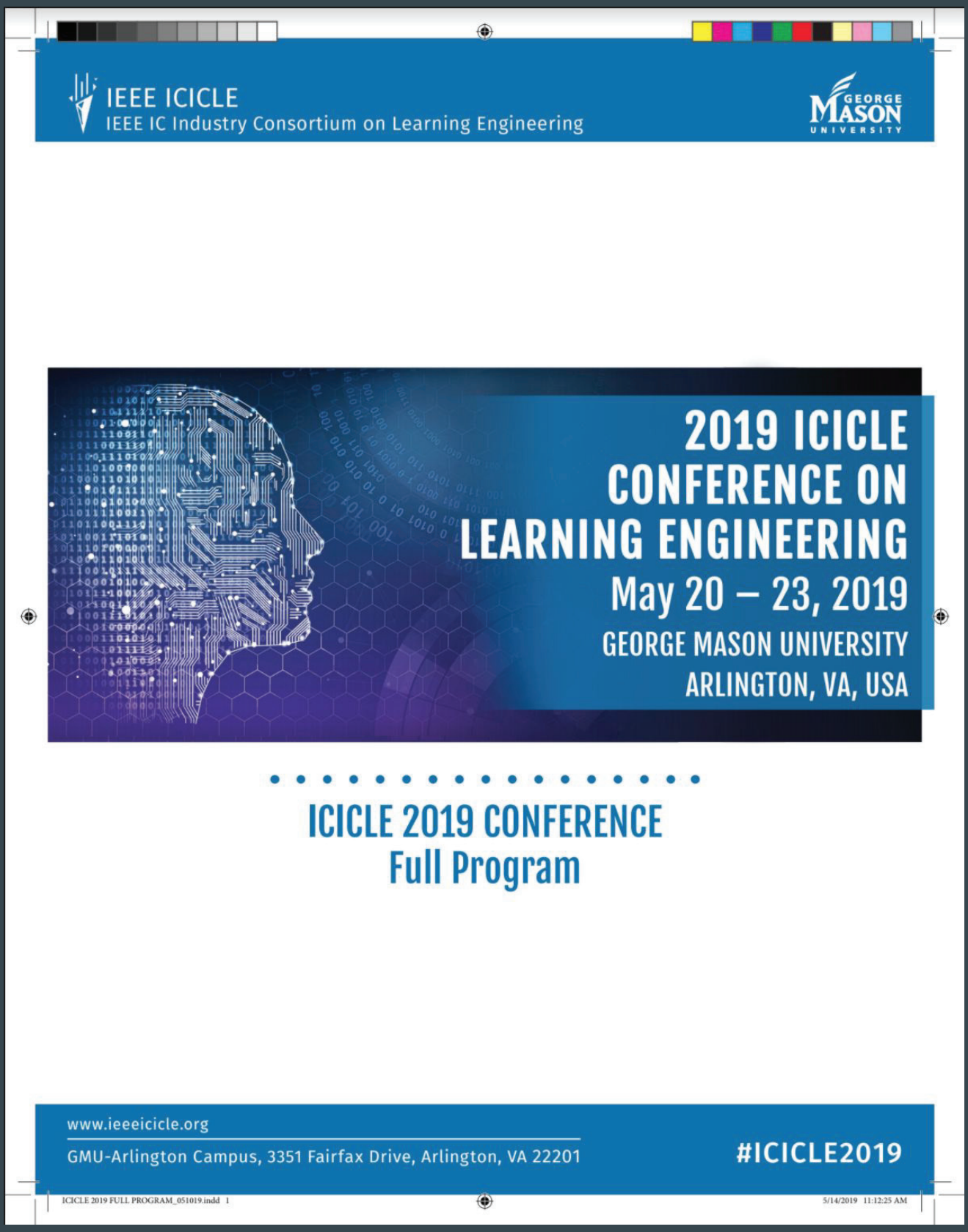
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2019 Conference Brochure

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Towards a Definition

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Learning Engineering is a process and practice that applies the learning sciences using human-centered engineering design methodologies and data-informed decision making to support learners and their development.



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Why ICICLE?

Shelly Blake-Plock

So . . .

ICICLE was formally established as an IEEE SA Industry Connections activity sponsored by the IEEE Learning Technology Standards Committee in December 2017. For the next two years, the question that I was asked most often as ICICLE's chair was: "What is Learning Engineering?"

And my usual response was: "We don't know."

In fact, this lack of definition around Learning Engineering is the reason that ICICLE was formed. Tasked with helping to convene an international conference for the purpose of bringing definition to the term and its application within industry, government, and academia, the consortium has benefited from the work of practitioners and scholars across fields, many of whom are represented in this volume.

You will find in these pages a variety of views, reflecting the ongoing evolution of a term with distinct connotations to professionals across domains serving the scalability of best practices in learning and in engineering.

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Why ICICLE?

As for that elusive definition? Well, over the course of two years, ICICLE sponsored special interest groups that engaged in conversation and debate around the meaning and meaningfulness of Learning Engineerings across applications to industry, government, and academia. The SIGs included the following:

- AI and Adaptive Technologies
- Data Governance and Privacy
- Design for Learning
- Learning Engineering among the Professions
- Learning Technology Data Standards
- xAPI and Learning Analytics
- XR for Learning and Performance Augmentation
- Competencies, Curriculum, and Credentials

With regard to a work-ready definition, the last group on the list made significant headway. It was the definition developed through hours of debate within that SIG that led to the Conference's answer to the question: "What is Learning Engineering?"

The answer:

Learning Engineering is a process and practice that applies the learning sciences using human-centered engineering design methodologies and data-informed decision making to support learners and their development.

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Why ICICLE?

While it should be noted that there was at the conference and continues to be ongoing debate especially between the variety of practitioners across the instructional design field and the engineering field, the definition itself holds up relatively well and is equally applicable across the variety of formats that a learning engineerings program or position may fill.

Regarding the ongoing debate, it looks like a matter where certain arguments fall on the side of engineering the design of learning that scales; whereas, others represent the side of technical engineering necessary for sustaining the scaling of learning. Both sides are equally invested in solving issues created by learning at scale—meaning both globally distributed learning and its impact on the design of learning experiences as well as the technical feasibility and requirements to support those experiences, as well as the impact of data and AI techniques on both the experience of learning and the outcomes of learning—not to mention the ways that we may come to redefine "learning" itself in the future.

The following pages represent the variety of views presented at the 2019 Conference on Learning Engineering. A note on format: the conference itself was designed as a series of conversations as opposed to a series of lectures and papers. This conference proceedings reflects this format. The goal within these pages is to represent the full range of conversations and to provide documentation of the gathering. The result is a curation of papers, reflections, presentations, demos, videos, and brainstorming. May this compendium not serve as the last word on Learning Engineering but rather as a starting point for further development in the field and in its practice across industry, government, and academia.

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What We Discovered at the Roots of Learning Engineering

Jim Goodell, with Mark Lee and Jodi Lis

Introduction

In mid-November 2018 Mark Lee, Jodi Lis, and I went back to where it all began. The place where more than 50 years ago the Carnegie Mellon University (CMU) professor Herbert A. Simon coined the term “learning engineering.” Simon, a Nobel Laureate, was instrumental in launching departments at the Pittsburgh-based university that continues to be a world leader in cognitive and learning sciences, learning technologies, and the application of the sciences to optimize human learning.

The IEEE IC Industry Consortium on Learning Engineering (ICICLE) had been meeting for almost a year. There had been amazing interest and great discussions in the various special interest groups that met almost weekly, but these groups had not yet reached consensus on a clear and concise definition of learning engineering. We thought that a visit to Pittsburgh to explore Herb Simon’s heritage might help add clarity to our own understanding of learning engineering and what we could offer various ICICLE special interest groups (SIGs) in which we participate.

Read the entire article

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I Want to Be a Learning Engineer

Avron Barr

Re-Engineering

Recent conversations about the competencies of a Learning Engineer have brought to mind my pre-ICICLE ideas about "re-engineering" concepts applied to the several ed tech markets. I started with imaginations about what kinds of problems LEs will be asked to solve, what kinds of solutions they will build, and what tools and materials they will use? We can't base our ideas about LE competencies only on what data scientists and instructional designers are asked to do today.

So, riffing off of Michael Jay's "I am a Learning Engineer because . . ." idea, I present for your consideration the following ambitions of some hypothetical youngsters. What knowledge, skills, and abilities will they need?

In my village, the teacher visited once a week and brought books and an Internet connection from her bus. When I graduate from college, I want to design, build, and operate a national e-learning wifi grid for our country using 5G technology. We will never have enough schools and teachers in remote areas. We can design a national school systems based on the grid and thus allow all students, teachers, and schools access to the best online learning materials.

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I Want to Be a Learning Engineer

When I was in high school, I used a remote telescope through an online lab to collect real data for my senior project. There's nothing like that available at my college. I want to start a company to make virtual labs available to every student.

My school's online Algebra II course is beautiful. I love the 3D graphics and online games. My team built the Great Pyramid in a Virtual Reality lab. But its AI algorithms are stupid. For instance, I took trigonometry online in the summer. My school gave me credit, but none of the courses here know that already know what a cosine is. I know that data scientists at Amazon have better algorithms, which seem to know about everything I do anywhere online. I wanna build a better AI for learning.

Math is my thing. But in high school I learned everything from Mr. Khan's Academy. My Ed School masters program is working with local school districts evaluating a new online math curriculum. I visit several schools once a week to work with teachers and observe the students. Truth is, current practices and policies make our system much less effective than it could be. When I graduate I want to work with school districts to completely re-engineer middle school math education.

I'm going to go to law school after I graduate. I always thought I'd be a programmer, but my Spring Break trip got cancelled because a hacker stole my deposit and I didn't even know. I want to make sure the law keeps up with technology, and I think there will be a lot of jobs for lawyers that sue companies about data breaches. I wonder if my college's records are secure!

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I Want to Be a Learning Engineer

I've been a fan of online learning since grade school. I'm getting a masters degree in LE this spring. A prospective employer recently asked for clarification about my issues with a big national publisher that my high school was using. Turns out the company could see all my online learning records, which I didn't even know existed. That's not right. I cleared up the issue, and when I finish my masters program, I got hired by the publisher to work with their head of data governance policy and operations.

My college uses the worst LMS in the world. I asked my professor, who was on the committee, about why they didn't use an cloud-based solution. His answer made me decide to start a consulting business, working with college and school district acquisitions committee to help them understand what they're buying and what assurances they need to put in their contracts about data governance about performance expectations about integration with existing systems, etc.

I'm a student teacher in middle school. I feel like I fighting my environment every day. Someday, I want to design a building that separates learning from daycare and maximizes the use of teachers' time by creating spaces that help teachers teach and help students learn.

I hate high school. This is stupid, watching a teacher stand up in front of the class giving the same lecture I saw online last night. I think the classroom is the problem. I want to design a new kind of classroom that takes into account the affordances of learning technology.

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I Want to Be a Learning Engineer

I've been working as an intern at a big, international tech company. My job is to put together a competency framework for our company that will be used for recruiting, company talent management, rapid team formation, internal training, and our certificate programs for our customers. Basically, I'm using spreadsheets — there are no adequate tools. When I finish my LE degree, I've been invited to come back and lead a product team to make this job make sense.

I love the way Netflix recommends stuff for me. At school, every day, every week, every year goes in every subject seems to go lock step along predetermined "right way to learn". There's plenty of online stuff in almost any subject nowadays. I want to build Netflix for learning where you build a profile and as you use it, it learns more and more about what works and what doesn't.

I took the "Data and the Law" course this year. First time my law school offered it. Did you know you can sue a school or a publisher if someone hacks them and steals your learning records? The number of cases is growing exponentially. Some of us second-year students are thinking about forming our own law firm that specializes in cases like this. But I'm thinking if I could publish a book and position myself as an expert, I could start a consultancy to help companies, schools and government agencies conform to the law. Way better than a year as an associate at a law firm.

I really don't know what I want to do, but I hear anybody can work on standards.

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Language Matters: Exploring the Use of Figurative Language at ICICLE 2019

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Jacob Fortman, University of Michigan

Abstract

This paper began as an exploration of metaphor and figurative language between colleagues and culminated in exploring the use of figurative language during the 2019 ICICLE Conference on Learning Engineering. We provide an anecdotal collection of metaphors and figurative language used during conference presentations and discussions and suggest ways in which we can converse more effectively around the notion of Learning Engineering to facilitate fluid, shared understandings that cross the boundaries of organizational backgrounds.

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A Little Background

To begin, it is important to understand that this paper began as a collegial debate about the merits of one metaphorical understanding of teaching over another. The debate began nearly three years ago in a colleague's office. Aaron mentioned the metaphor Instructional Engineer (Kessler, 2015) in the conversation and my (Chelsea) immediate reaction was to cringe—noticeably. My mind quickly connected the word engineer to the social efficiency and scientific management traditions of the early 20th century (Null, 2010).

My understanding of social efficiency relates to the work of three prominent figures during the early 20th century: David Snedden, Franklin Bobbit, and Frederick Taylor. The common thread connecting Snedden and Bobbit's work, according to Null (2010), is the idea that schools should "look to the needs of industry" in the creation of curricula geared toward occupations and vocational training (p. 791). While Taylor was not directly associated with the tradition of social efficiency, his beliefs in the application of business principles in schooling were very much in line with Snedden and Bobbit's interest in vocational training.

According to Barone (2010), Frederick Taylor's work included removing the design of curricula from teachers and handing it over to efficiency experts who would then engineer efficient designs that would maximize the amount of material taught to the "greatest number of students in the least amount of time" (p. 321). Having read and critiqued the works of

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these men, my own biased filter made the connection between social efficiency, scientific management, and Aaron's conception of Instructional Engineering. Without further discourse, I would not have been introduced to a new frame from which to view the idea of engineering in education.

Through conversations, Aaron helped me understand that his notion of the term Instructional Engineer was different from my conception. Instead of teachers being taken out of the equation, Aaron's metaphor conceived teachers as engineers who design, build, and implement solutions to complex problems that are situated in environments with dynamic variables.

For Aaron, the realization that the metaphor of Instructional Engineer could be misconstrued by other education colleagues was a harsh realization. The purpose of using the metaphor was to help distill down pages of detailed description of the work required to be done by educators to enact reform instruction in complex settings into something that could easily be understood by both researchers and practitioners alike. Despite the goal of better communicating the complex work required of classroom educators the metaphor, only further complicated some of the arguments Aaron was attempting to build, as it required understanding and negotiating colleagues' own perceptions of the work associated with engineering.

Fast forward three years—both Aaron and I have since moved out of faculty roles and are currently assisting in the design of learning environments at MIT and The University of Michigan (U-M) respectively.

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We had a lull in the debate regarding Instructional Engineering, but as ICICLE 2019 approached, Aaron mentioned that the topic of discussion at the conference might interest me: Learning Engineering. I was enticed by the conference for two reasons. First, for the practical purpose of exploring university programs offering degrees in Learning Engineering. Second, from the standpoint of continuing to explore what Learning Engineering actually means in a variety of contexts.

In May, Aaron and I attended the IEEE ICICLE conference along with Jacob, a Learning Experience Design fellow from the Office of Academic Innovation at U-M. Each of us came away from the event with a variety of figurative phrases we encountered and a realization that many people at the conference were using metaphors and figurative language in conversations with people of diverse backgrounds. Much like our conversation around Instructional Engineers three years ago, we began to notice challenges, potential complications, and possible opportunities in discussing the idea of Learning Engineering using such language.

Collecting Figurative Language Use at ICICLE 2019

The ICICLE 2019 conference attracted numerous individuals from academia, private industry, and government agencies. It seems as if the ideas and discussions around Learning Engineering appeared to capture the attention of these diverse stakeholders. While a diversity of organizations and professions allows for exciting collaborative potential, it also entails some challenges, particularly when stakeholders have diverging understandings, interests, and contexts, which can manifest in vastly

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different uses of language seemingly all describing the same idea.

During the conference, we collectively recorded, in a shared document, anecdotal instances of figurative language used (Table 1). We found that the language used went beyond metaphor and included other types of figurative language. It is not our intention to suggest this is an exhaustive list. Simply, we aim to capture examples that the three of us experienced, individually and collectively, during the conference. As such, we will leave the instances unelaborated to serve as a heuristic for considering the language we use in a diverse community.

Descriptions of Learning Engineering as a Field

- Jazz Improvisation
- Flower
- Many Cogged Machine
- Process
- Mirrors, Doors, and Windows for Inclusion
- Art of the Possible
- Tree
- Horizons of the Field
- Bridge Being Built Over a River

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Descriptions of Learning Engineers

- Jazz improvisation
- Sherpa
- Change Agent
- Systems Engineer
- Conductor
- Test Engineer
- Build Bridges

Descriptions of Feelings Evoked During Dialogue

- Drink Our Own Champagne
- Eat Our Own Dog Food
- Either Get on the Bus or Get Under It
- Infection
- Pipeline of Learning Engineers

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Each of the anecdotal examples listed previously was intentionally left unelaborated. As one might notice, these uses of metaphor and figurative language have the potential to present both challenges and opportunities for extended dialogue. Unfortunately, many of the examples were said and left for conference-goers to take at face value with little elaboration or analysis.

Discussion

Anna Sfard's article in the Educational Researcher entitled On Two Metaphors for Learning and the Dangers of Choosing Just One offered inspiration and guidance for us as we considered the figurative language used. In the article, Sfard (1998) described her analysis of two metaphors specifically related to the way in which K-12 students learn: acquisition and participation. The first metaphor, Acquisition, was based on the idea that knowledge is something that can be possessed and accumulated over time. The second, participation, situated learning as something that is active—beyond the accumulation of knowledge.

What does this have to do with our discussion of metaphors and figurative language? Well, Sfard's (1998) difficult conclusion was that we must learn to live with both metaphors—finding value in each when the context is right and the evidence thoroughly convincing. She suggests that it is important to remember that metaphors utilized in efforts to theorize may suffice to fit certain portions of a field, but they will not create a "unified, homogenous" phrase to conveniently explain all of the complexity and nuance of our work

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(p. 12). It is no new thing to conceive of metaphors and other types of figurative language to re-describe abstract ideas. This type of language helps us to understand the world in which we live. What may be new in this context—in this moment in time—is to consider how we, as a diverse community of stakeholders, might develop ways of communicating more productively that move beyond the assumption of universal understanding.

In her article, Sfard (1998) alluded to the importance of dialogue and continuous conversation within a community. In the case of our community of educators and professionals in industry and government, this means that we should take care to thoughtfully communicate the meaning of our words and continue to speak openly to each other about our unique contexts.

To address these challenges, discourse around Learning Engineering needs to take account of the diverse stakeholders by understanding specifically how learning engineers function between contexts. While there may be many points of divergence, one point of convergence between academia, industry, and government is in the need for establishing competencies for Learning Engineering. Establishing competencies is crucial for developing graduate curricula, hiring learning engineers, communicating across institutions, and organizing project responsibilities. While there may be broad agreement on the need for competencies, establishing what these competencies are is a more challenging task.

For instance, one potential competency discussed throughout the duration of the conference was that of the application of learning sciences research. The

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dialogue around this competency included questions about whether the application of the learning sciences is relevant for learning engineers in an industry context. In this instance, it would have been helpful to elaborate on how the learning sciences are being applied and then compare this understanding to another context. By elaborating and comparing across contexts in this way, diverse stakeholders will be able to shed light on diverging understandings and interests within learning engineering.

One critical point in developing these competencies is assuring that the language used to describe the work of learning engineers(ing) is also clearly understood and jointly negotiated by the diverse stakeholders throughout the development and instantiation process. In the remainder of this paper, we propose a set of recommendations for engaging in conversations and negotiations with other stakeholders across the Learning Engineering community.

Recommendations

Since the catalyst for this endeavor was the misunderstanding of a metaphor, we certainly acknowledge the benefits of having multiple metaphors as potential heuristics. The potential learning and shared understanding (if not agreement), however, lies in the hands of those having conversations about Learning Engineering. To do this work, we have included several recommendations for communication and discourse when interacting with a passionate and diverse group of stakeholders. The first set of recommendations is for those listening to others speaking. We suggest

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listeners try to be open-minded, to attempt to suspend judgment while listening to others speak, to assume that the speaker is coming from a place of positive intent, and to respectfully highlight points of clarification. Attempting to achieve a state of open-mindedness may help listeners notice important distinctions and points of convergence for further conversation while reducing miscommunication.

The second set of recommendations is for those who are actively speaking. Most importantly, be aware of the metaphors and figurative language used to describe Learning Engineering. By articulating these specific ideas, we limit opportunities for others to misinterpret our intended ideas in favor of their own conceptions of what the metaphor could imply. Second, be open to elaborating on context-specific ideas, metaphors, or other figurative language you are using.

Third, if listeners do not ask for explanations or clarification, consider furthering the conversation by asking others what they think about when they hear the metaphor or figurative language being used.

Our final recommendation is specific to those presenting on topics related to Learning Engineering or Learning Engineers at conferences or in professional settings. When participating in group presentations or large group discussions, presenters should attempt to limit the number of metaphors and instances of figurative language used unless such language is deemed integral. Metaphors and figurative language used should be contextualized and concretized by elucidating explicit examples of the related Learning Engineering work.

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Language Matters: Exploring the Use of Figurative Language at ICICLE 2019

As our diverse community moves forward and prepares for ICICLE 2020, these communication considerations may help coalesce instances of convergence and more importantly open points of divergence up for continued discussion. Explanation of the language we use combined with explicit examples of the work of and around Learning Engineering may make it more likely that we can facilitate fluid, shared understandings that cross the boundaries of organizational backgrounds.

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ICICLE: Historical Articles and Presentations 2017–2019

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IEEE ICICLE Official Public Kickoff Meeting, January 2018

Avron Barr, Jodi Lis, Shelly Blake-Plock, Robby Robson, Megan Bowe, Frank Polster



Overview

ICICLE was approved as an Industry Connections activity by the IEEE Standards Association in December of 2017. On January 3, 2018, we held our first public community call.

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What is a Learning Engineer? Presented at Emerge Africa, July 2018

Jodi Lis



Overview

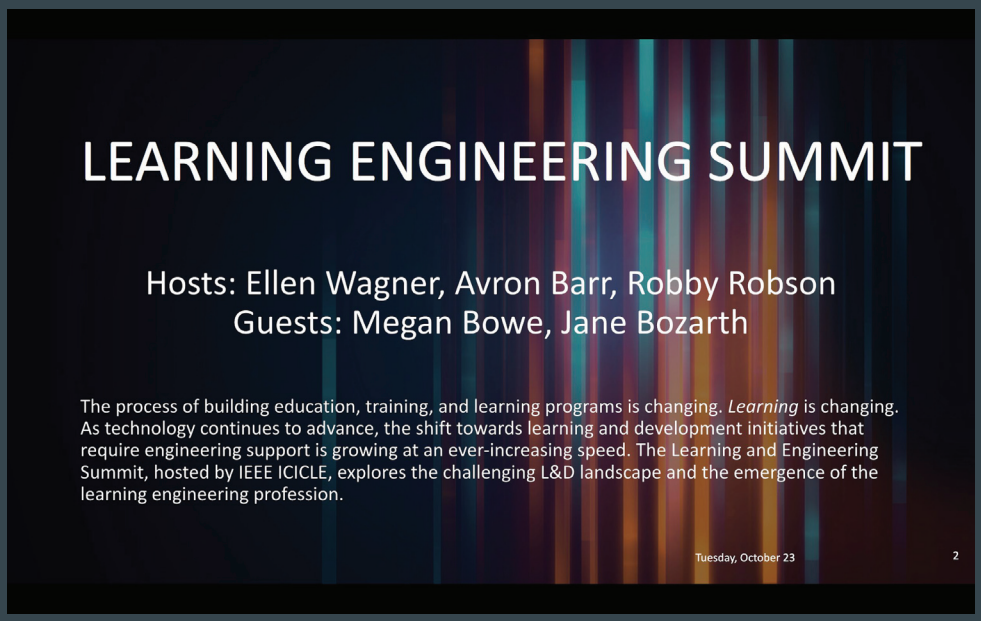
This presentation covers background on Herb Simon and discusses the presenter's journey into Learning Engineering. It provides background on what and who makes up Learning Engineering. Finally, it wraps up with Getting Involved: IEEE IC Industry Consortium on Learning Engineering (ICICLE).

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Presentation from the Learning Engineering Summit at DevLearn, October 2018

Ellen Wagner, Avron Barr, Robby Robson



Overview

The process of building education, training, and learning programs is changing. Learning is changing. As technology continues to advance, the shift towards learning and development initiatives that require engineering support is growing at an ever-increasing speed. The Learning and Engineering Summit, hosted by IEEE ICICLE, explores the challenging L&D landscape and the emergence of the learning engineering profession.

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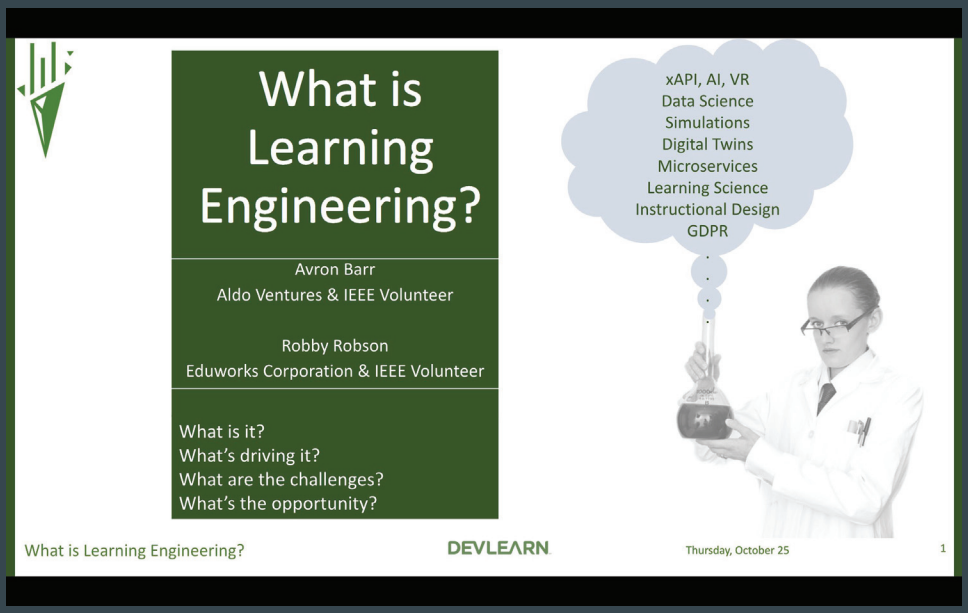
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What is Learning Engineering? Presented at DevLearn, October 2018

Avron Barr, Robby Robson



Overview

"As innovative teachers, schools, and training departments deploy an ever-expanding array of new products and explore new ways of teaching and learning, the body of knowledge about how to use these technologies and how to design the increasingly complex information systems that result is the basis for a new engineering discipline." — Avron Barr

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Learning Engineering: Areas of Development

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The ICICLE 2019 Conference on Learning Engineering was organized around the following three questions:

- What are the competencies of learning engineering?
- What do we know about learning, and what does our knowledge suggest about design of learning experiences, conditions for learning, and use of supporting technologies?
- How will the emerging learning engineering profession address privacy versus personalization?



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Competencies of Learning Engineering Teams and Team Members

Jim Goodell, Aaron Kessler, Dina Kurzweil, Janet Kolodner

Introduction

The types of educational problems that previous generations were tasked with solving could be addressed in particular silos (for example, software design, instructional design, teaching, educational technologists, etc.). We've never designed educational opportunities that meet the needs of all learners, and we're at a time in history when that needs to be the goal. Technology offers new opportunities for addressing these goals, but we still need to discover the best ways of using it. Thus, we are at a crossroad where problem solving for learning requires the integration of expertise from across a variety of team members who can work together to solve the problems of today and in the future. Multiple types of expertise are required from across numerous professions that requires new sets of team competencies and porcessies. Like many other fields tasked with solving complex, everchanging problems, the work of learning engineering requires a multidisciplinary approach.

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Competencies of Learning Engineering Teams and Team Members

The kinds of engineering problems associated with supporting, enhancing, and creating equitable, effective life-long learning opportunities and conditions possible in the future have not yet been fully identified. The types of problems that previous generations were tasked with solving could be addressed in particular silos (software design, instructional design, teaching, educational technologists, etc.). We've never designed educational opportunities that meet the needs of all learners, and we're at a time in history when that needs to be the goal. Technology offers new opportunities for addressing these goals, but we still need to discover the best ways of using it. Thus we are at a crossroad where problem solving for learning requires the integration of expertise from across a variety of team members who can work together to solve the problems of today and in the future. Multiple types of expertise are required from across numerous professions that requires new sets of team competencies and porcessies.

While the current professions tackling these types of problems can be situated in silos, an integrated approach is far more likely to develop the necessary solutions. In fact, many people, including most who have contributed to these very proceedings, have advocated for the integration of professional practices and expertise from across the learning sciences, instructional design, software engineering, user experience design (UX), and others aimed towards imagining and designing the kinds of learning experiences afforded by new technologies and new ways of using technology and the as learning engineering.

Like many other fields tasked with solving complex, everchanging problems,

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Competencies of Learning Engineering Teams and Team Members

the work of learning engineering requires a multidisciplinary approach. The image below attempts to capture the beginnings of this idea and provide some insights into the shared and distributed understanding necessary to engage in the work of designing for learning.

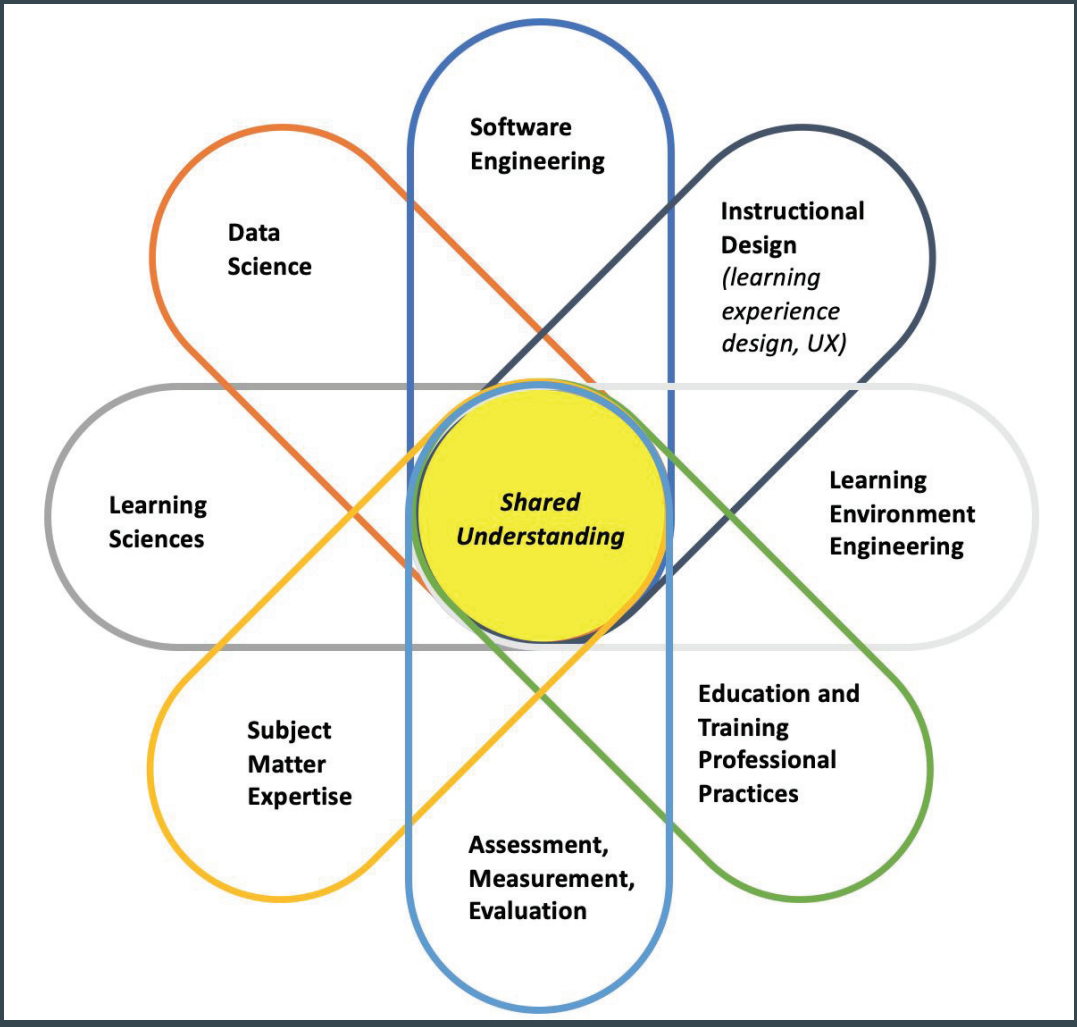


Figure 1: Learning Engineering Teams (CC BY 4.0 Jim Goodell)

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Competencies of Learning Engineering Teams and Team Members

In Figure 1, each petal of the flower in the image represents a field that has previously been associated with design for learning. (Note: Other fields and areas of expertise might need to be added to a learning engineering team depending on the specific project or problem.)

The goal of the image is to demonstrate how learning engineering teams are made up of many types of expertise (each petal) while also having shared understandings (the central circle) that are critical for solving complex challenges.

Determining the correct distribution of members that are part of a team doing learning engineering will depend on the product being designed (technological system, instructional intervention, data visualizations, etc) and the context or problem the product is intended to address. The team will, together, have an understanding of how people learn, design processes, and using data to make informed decisions.

Further, they need to share a specific mindset or set of dispositions, possess collaboration skills and knowhow, and imagination about ways technology can support learning. That means that while everyone doesn't have to be an expert in all of the petals (silos), they need to be able to collaborate and work with those who have the necessary expertise to achieve the necessary requirements for the project. Successful collaboration in such ways are likely the result of all team members having dispositions and habits of practice that fit into the following categories:

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