Learning Engineering Toolkit

Evidence-Based Practices from the Learning Sciences, Instructional Design, and Beyond

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First published 2023

ISBN: 9781032208503 (hbk)
ISBN: 9781032232829 (pbk)
ISBN: 9781003276579 (ebk)

Chapter 1

Learning Engineering is a Process

DOI: 10.4324/9781003276579-6

The funder for this chapter is Jim Goodell

Routledge
Taylor & Francis Group
NEW YORK AND LONDON

CHAPTER 1

Learning Engineering is a Process

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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.

A process is a series of actions or steps taken in order to achieve a particular end.

A process has:

1. inputs
2. process steps
3. outputs

Baking chocolate chip cookies is a process defined by a recipe. It has inputs (the ingredients), action steps (directions), and outputs (the cookies). Baking one batch of cookies is a project. The recipe defines a repeatable process that may be iteratively adjusted and improved.

Learning engineering is also a repeatable process intended to iteratively design, test, adjust, and improve conditions for learning. It starts with a challenge. The scale of that challenge could be small and focused, such as the need to prepare students for a class of difficult problems on a high-stakes test (see Chapter 6), the scale may be the design of a global learning platform serving education in a whole variety of disciplines for millions of students (Chapter 4), or the scale could be of any size in between. The nature of the challenge could be about teaching adults to

DOI: 10.4324/9781003276579-5

adopt healthy behaviors (Chapter 3) or motivating middle school students to engage in more productive learning behaviors (Chapter 6). It could be about tactical training for teams of soldiers (Chapter 5) or ethical training for medical professionals or any other learning context (Chapter 7).

True stories featured throughout this book demonstrate the wide variety of challenges addressed with the learning engineering process, such as the following:

- Optimizing learner experiences on a global language learning platform (Introduction, Chapter 5, and Chapter 6)
- Getting kids to where they'll be learning in West Africa (Introduction)
- Designing curricula and professional development and scaling a new learning technology for broad use (Introduction and Chapter 6)
- Developing software for a collaborative VR experience to help learners understand a complex scientific concept (Chapter 1)
- Designing numeracy games for two- to three-year-olds (Chapter 3)
- Designing for low literacy users and in humanitarian settings (Chapter 3)
- Engineering a global learning platform serving 3,000 university-level courses to about thirty-three million students (Chapter 4)
- Providing the right level and frequency of feedback (Chapter 4)
- Designing sensors for learning analytics for military training (Chapter 5)
- Designing game-based learning for four- and five-year-olds (Chapter 5)
- Developing a platform for collecting learning analytics from game-based learning (Chapter 5)
- Discovering with a multidisciplinary team why results from a formative assessment delivered immediately following online instruction yield a poor pass rate (Chapter 6)
- Designing simulated training for medical professionals (Chapter 7)

Additional examples are provided as visions for the future of learning engineering (Chapter 19) and in supplementary case studies. As the contexts and needs for learning change, the learning engineering process has the potential to address future challenges that we cannot imagine today.

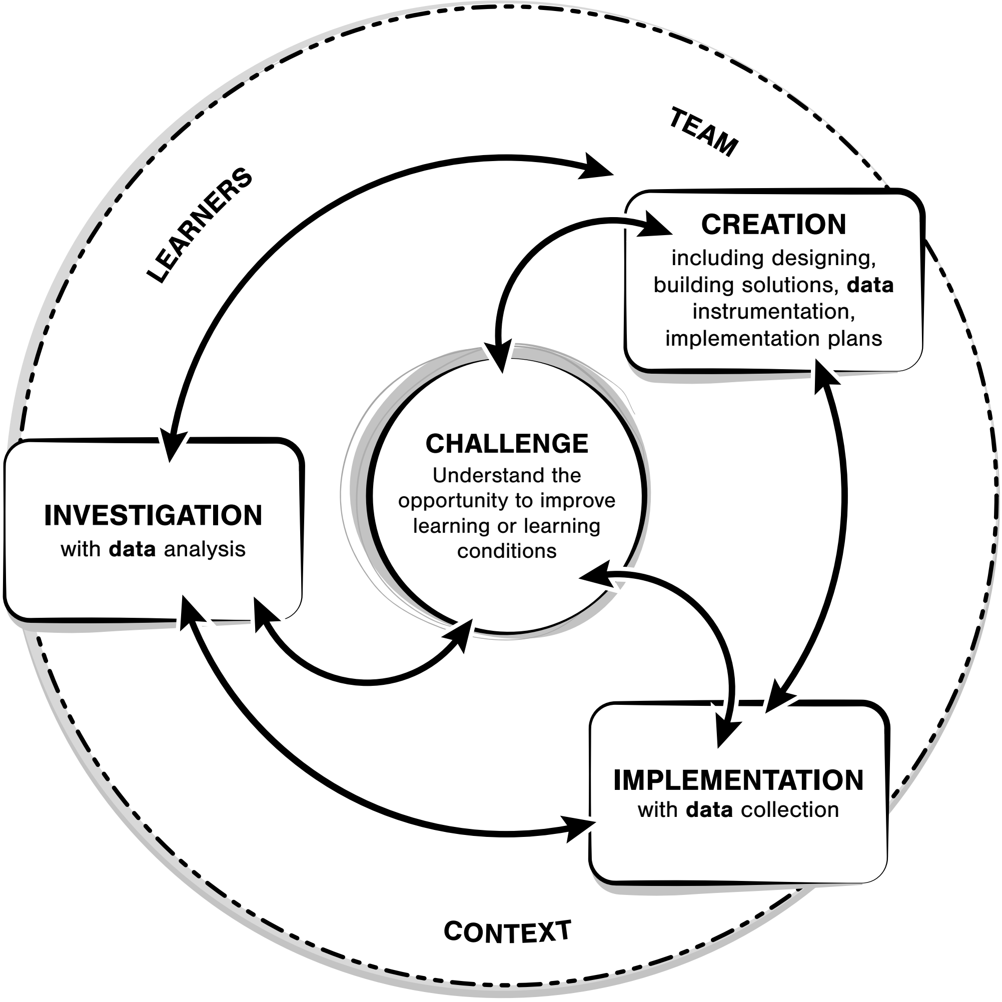

FIGURE 1.1. The learning engineering process

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[1]

In 2020, Aaron Kessler of MIT's Open Learning led development of a draft learning engineering process model with the Design for Learning Special Interest Group of the IEEE Industry Connections / Industry Consortium on Learning Engineering (ICICLE). This chapter presents the next iteration of that model that considers the parts concurrently as a cycle, with a challenge at the center. The chapter also provides a concrete example of how the process was used at MIT to develop a VR learning experience called the Electrostatic Playground.

Figure 1.1 shows a high-level view of the process. It starts with a challenge (an opportunity to create or improve learning conditions) and follows with investigation, creation, and implementation of a solution. The exact order and specific work to be done will vary based on the nature and scale of the challenge and other factors. However, the learning engineering process always involves multiple iterations, and it always uses data to inform decisions.

The outcomes that can be achieved by engaging in this process are broad. Therefore, the model is designed to work across a multitude of settings, levels of education and training, kinds of challenges, and groups of people. The specific process will vary based on the challenge, learner context, team context, available resources, and other factors. Specific processes used by a large team may be different from or the same as those used by a small team, and the process for developing a simulation may be different from the process for designing a project-based learning experience.

In this chapter, we use the example of a learning solution developed at MIT. This is just one example; the other examples throughout the rest of the book offer other kinds of challenges that can be addressed by using the learning engineering process. Despite these differences, the core of the process represented in Figure 1.1 is seen throughout these examples and can help those hoping to engage in learning engineering to organize their work in purposeful ways.

[2]

Challenge

Learning engineering always begins with a challenge or problem associated with learners and learning. The inputs required to identify the challenge can come from many different sources. For example, a new challenge may come to light based on data from a previous cycle of the learning engineering process. The challenge may be a changed environment or business process that requires new learning for people in the workforce. Challenges can be noticed as new learners join a community with different needs requiring changes to the status quo. The opportunity to improve learning might address a topic known to be challenging within a field or domain of teaching and learning.

Regardless of how the challenge is illuminated, understanding the challenge (or the problem you are trying to solve) includes understanding the learning objectives, the learner(s), and the conditions that will hinder or help learners reach the

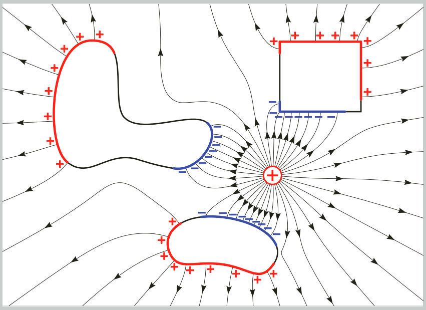

FIGURE 1.2. Two-dimensional electrostatics diagram

Electrostatic Playground Challenge

Electrostatics is the branch of physics concerned with electric charges at rest, and it is typically covered in the introductory physics curriculum. Many students lack familiarity with the concepts since they are difficult to directly observe or visualize in the real world. Within electrostatics, Gauss' Law is one of the most challenging topics, largely because it is fundamentally 3D, and therefore difficult to imagine or to capture in 2D whiteboard sketches. A further consequence of this is that it impedes instructors and learners from jointly attending to interactions (for example, sharing experiences of asking questions or checking for understanding) around the phenomena. One potential solution to this problem is to use 3D representations in a digital environment, using, for example, VR.

The Electrostatic Playground project set out to provide students opportunities to engage with electrostatic representations in a VR environment. In this project the main challenge to be addressed in the learning engineering process was to get students to collaboratively engage with electrostatics representations in ways that produced key insights about basic principles of physics.

targeted goal. As in other engineering disciplines, learning engineering does not start with a solution looking for a problem, rather the key to the process is to thoroughly understand the challenge before seeking solutions.

The Electrostatic Playground project is small compared to some projects. It focuses on a limited set of learning objectives for introductory physics students in a specific university course with access to VR equipment. Regardless of the size of the work, defining the challenge to be addressed is central to the work. (Chapter 8 offers tools for understanding the challenge.) It is also critical to realize that challenges are not static or self-contained, in fact, it is highly likely that to address a challenge you must address a set of sub-challenges. If the primary challenge is to develop a learning experience, sub-challenges include the need to develop instrumentation and plan implementation along with sub-challenges related to developing and iteratively improving the learning objects themselves. New sub-challenges will arise as the process is followed, for example, testing a prototype may identify new problems to be solved to fully address the primary challenge.

In the case of the Electrostatic Playground example, a sub-challenge involved the limited ways the typical VR system logged data about user activity; often a single "eye in the sky" structure is used (like a single video camera looking down on the action instead of separate cameras showing all points of view). Because the project was concerned with collaboration between participants, data limitations had to be addressed to investigate potential collaborative learning experiences. Lacking such data would limit opportunities to understand the impact of the designed solution and hinder future rounds of improvement. These multiple levels and types of challenges are often the hallmark of work that can be addressed using the learning engineering process.

[3]

Challenges to be solved using the learning engineering process do not occur in black boxes, instead they are situated within specific contexts. The context circle (dotted line in the learning engineering model diagram) encompasses the defined challenge and the entire process and is intended to be an outer bound for two main contextualized groups, learners and the learning engineering team.

Learners

Learning is situated. This means that learners in different situations, with different resources, learning conditions, and backgrounds will interact with each other and with resources very differently. This will lead to different learning experiences and outcomes. The learning context includes:

- People (learners, teachers, tutors, other learners, and others supporting)
- Environment(s) (virtual or physical)
- Learner backgrounds and prior knowledge
- Cultural norms for learners' home, community, and learning community
- Available tools
- Everything about the population of learners and potential learning conditions that may help or hinder the learning

The stories in Chapter 3 highlight the stark differences in learner contexts that must be considered when developing solutions to learning engineering challenges. For example, developing effective online learning activities for two- to three-year-old

Electrostatic Playground: Learner Context

The learners were first-year introductory physics students who were well versed in using mathematical formulas to represent and solve physics problems in a stepwise process. However, most had minimal prior experience engaging with visualizations or representations of electrostatics-based phenomena to develop more conceptual understandings. The project partially aimed to address this by having students engage with the content and other students in a VR environment. In this course students work on problem sets throughout the semester with the same group of two or three students, and many opted to sign up for the VR session with these partners. This meant that the students were accustomed to communicating and problem solving with their VR session compatriots. Thus, the work associated with learning community norms was something established in the traditional class work and was able to be leveraged in the context of the VR setting. Finally, the VR environment was constrained to focus only on a small set of learning goals, meaning learners engaged with the proposed VR implementation would not be exploring other physics phenomena at the same time.

children is very different from designing activities for four- and five-year-olds and completely different from designing simulated hospital settings for helping medical students learn new procedures. These, in turn, are quite different from educating low literacy learners in developing nations. Also see Chapter 2, Learning Engineering Applies the Learning Sciences, for insights on how people learn and the science applicable to contextual conditions for learning.

Team

Challenges that must be solved using the learning engineering process are highly complex and often require a team of people in order to develop appropriate solutions. Learning engineering teams bring together specialists in the realms of education, technology, and training to address a challenge.

Large teams may use different processes or the same ones used by small teams. The value of these teams does not lie entirely in their current individual abilities, but also in the team's ability to grow, develop together, and address the complex challenge collaboratively. A shared disposition toward growth and improvement, when combined with the shared knowledge of the team, makes the solving of learning engineering challenges possible. This team-oriented approach is recognized as a

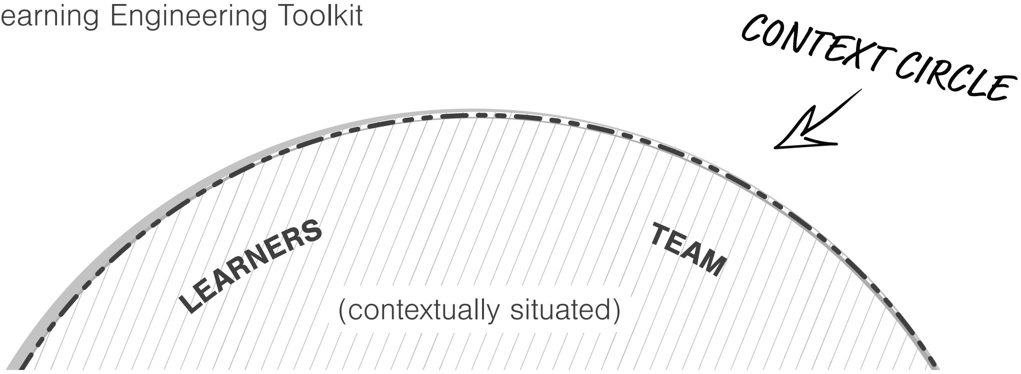

FIGURE 1.3. Learning engineering process detail: learners, teams, and context

common practice for the development of e-learning in the corporate training domain.

Learning engineering as a team process builds on professional specialties within the engineering team through a coordinated effort rooted in a shared understanding and vocabulary. The learning engineering flower graphic (Figure 0.5 on page 13) shows professional domains that might be required to address a learning engineering challenge. The professionals on the team require some shared understanding of the challenge and enough understanding about the other domains to effectively communicate as a team. (See Chapter 10, Tools for Teaming, for more discussion on learning engineering teams.) Learners and other stakeholders might also be considered part of the team.

Context

The context circle is meant to be a reminder to those engaging in the learning engineering process that these two groups, learners and the learning engineering team, are situated in contexts that will have norms, expectations, affordances, and limitations that will need to be taken into account as work on the central challenge is carried out.

[4]

Creation

Moving to the outer portion of the process from the central challenge is not a one-size-fits-all proposition. Depending on some of the contextual factors discussed above, a team working to address a challenge may be able to begin their work in any

Electrostatic Playground: Team Context

The Electrostatic Playground project was initiated and led by a research scientist in human-computer interaction with a focus on learning sciences and a prior background in mathematics and physics. The project scope grew to involve a team that included subject-matter experts, VR systems developers, and educational researchers. The subject matter experts contributed on three levels:

(a) suggesting technical (software implementation) approaches,

(b) suggesting component user experiences (tools and corresponding visualizations), and

(c) providing guidance on scaffolding for curriculum alignment (narrative segments and corresponding exploratory activities).

The primary subject-matter expert was an instructor familiar with simulation techniques (relevant here because a simulation-based, exploratory experience is being designed) who could therefore contribute on all three levels. Three other course instructors also contributed to the last two areas (b and c). Six teaching assistants were recruited to participate just in category (c), first by holding live office hours in the multiuser VR space, and after gaining experience with that, structuring recorded narratives with suggested activities that aligned specifically with elements of the course curriculum. All of the subject matter experts were responsible for implementing the learning environment with students.

The VR systems developers, including the project lead and two software engineers, handled the detailed user experience design and software implementation, including the physics simulation (with guidance from the primary subject matter expert), building the environment, creating usable data structures, conducting user testing, and supporting the final implementation with students. During the process they were able to contribute original component user experiences, which could then be validated and integrated by the instructors.

Finally, the educational researchers (a senior learning scientist and an undergraduate intern) were responsible for providing feedback on how the data collected during the implementation could be analyzed, engaging in reflection on results in connection with stated goals of the work, and connecting data outputs with potential changes to the user experience and scaffolded curriculum for the next round of implementation.

Electrostatic Playground: Creation

Early on, the team identified the topics of electric flux and Gauss' Law as good matches for the technology. They're topics that students have difficulty with (and therefore would represent an opportunity for clear benefit), and the relevant conceptual constructs are particularly 3D in nature (difficult to explain in 2D and requiring 3D mental manipulations).

On this basis, the learning engineering team discussed how they could leverage the affordances of VR to encourage joint collaboration among students as they explored field lines and Gaussian surfaces. This collective team structure allowed for the concurrent development of the learning experience and VR system to capture students' actions and attention in ways that could inform iterative improvement later in the cycle.

After an initial round of development with the subject-matter experts describing critical features that students should attend to, the developers coded those ideas into a usable form in the system, and then a series of user tests was conducted. Graduate students, staff, and other subject-matter experts were asked to engage with the system while designers, developers, and a researcher observed.

The initial design, which included both technology and interaction design elements, was meant to be a sandbox where learners would be introduced to the tools available in the system and allowed to freely explore features and relationships among objects. This system was piloted in a live tutorial setting, with teaching assistants instructing one or two students directly in the environment without a specific script or lesson plan. Beyond the observation of the test, data were collected in the form of a playable recording that could replay the session in 3D, either immersively (in VR) or non-immersively (on a desktop PC).

Two key actions resulted from this user test. First, across the team everyone agreed that a series of short instructor-led prompts, to partially guide and get learners started in the exploring and noticing of critical features, needed to be created by the subject-matter experts. The resulting explanatory components of the learning experience took the form of mini-lectures recorded by an instructor within the VR system and played back by the learners as they begin each learning segment. These mini-lectures would end with the prompt, "Now it's your turn," from the instructor, indicating that the learners should begin exploring the interactive elements. This explanatory-exploratory structure was repeated with several cycles of consecutive prompts before learners were given a final opportunity to engage in free exploration of the environment.

Second, the learning engineering team noted that the third-person perspective associated with the session recordings made it difficult to observe when and where learners were exhibiting joint attention to objects. As a result, the developers recommended adjusting the VR system to allow for spatial recording. This technique allows viewers to adopt any perspective, but for the purposes of efficiently seeing what each learner was attending to, the first-person perspective was the most advantageous.

This decision to instrument the system to capture the learning experiences from each student's perspective would later turn out to be incredibly valuable in understanding when and how learners had *aha!* moments. Had the team not been working collaboratively and concurrently on these parts of the process, it's likely that the process would have, at best, been extended, and given the nature of the questions and ideas raised in the collaborative meetings, the resulting VR experience may have looked very different.

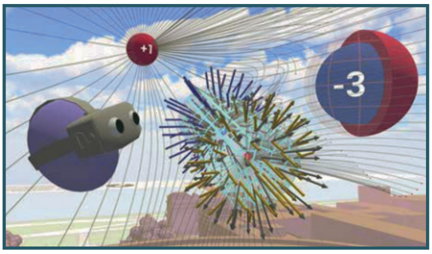

FIGURE 1.4. Playback from the Electrostatic Playground VR

one of the outer action steps of the process. For the purposes of this chapter, we start with the creation step; however, teams might begin with implementation and or investigation depending on the challenge established at the beginning of the process and the context in which they are working.

The creation portion of the process contains several key mini and iterative cycles of the learning engineering process that include designing, developing, instrumenting, and user testing potential solutions. Remember that these are happening simultaneously. For example, a simple paper prototype (creation) may be tested (implementation) with a small focus group to collect initial data for checking suitability of a design (investigation).

A key feature of the creation portion of the process is that the mini-processes should be considered concurrently rather than sequentially. This concurrent work requires the person or people working to solve the challenge to engage in the work of creation in cycles that take into account:

1. What's known from the learning sciences literature that can inform the designed solution (Chapter 2)
2. Human-centered and engineering practices to improve initial design into a viable solution that will function as intended in the contextualized operating conditions (Chapter 3 and Chapter 4)
3. How data related to targeted learning can be collected and analyzed (Chapter 5 and Chapter 6), both to support learning and as feedback for refining the solution
4. How values and ethics are embedded within the design and implementation process (Chapter 7)

In many current settings, especially within education technology companies, each of these sets of mini-processes is completed independently. For example, a designer creates a set of specs that are handed to the development team, who builds a solution that is handed off to the implementation team, who collects data and hands it off to the data scientist, and so on. The Electro VR example provides a view into how the learning engineering process can bring these sometimes disparate mini-processes together into a Lean-Agile or concurrent, and potentially more coherent, creation process. (See also Chapter 11, Lean-Agile Development Tools.)

[5]

Implementation

Once a potential solution to the learning engineering challenge has been created, the process shifts to focus on implementation. As discussed earlier in the chapter, the context of the learners and how they will be supported in their specific environment must be initially considered as you define the challenge, and implementation planning must be part of the concurrent work done in the creation phase. The implementation phase of the learning engineering process involves having real learners in real contexts engage with the output from the creation stage. Implementation is not limited to full release or full-scale implementation of a product or solution.

Note that the Electrostatic Playground context allowed for a comparatively straightforward implementation: Subject-matter experts, who were also the instructors of the course in which the system was implemented, along with their teaching assistants for the course, who were also the user testers, enacted the instructional plan and facilitated the VR experience. This may or may not be the case for other learning engineering contexts.

When an implementation is more wide-ranging, usually later in the iterative

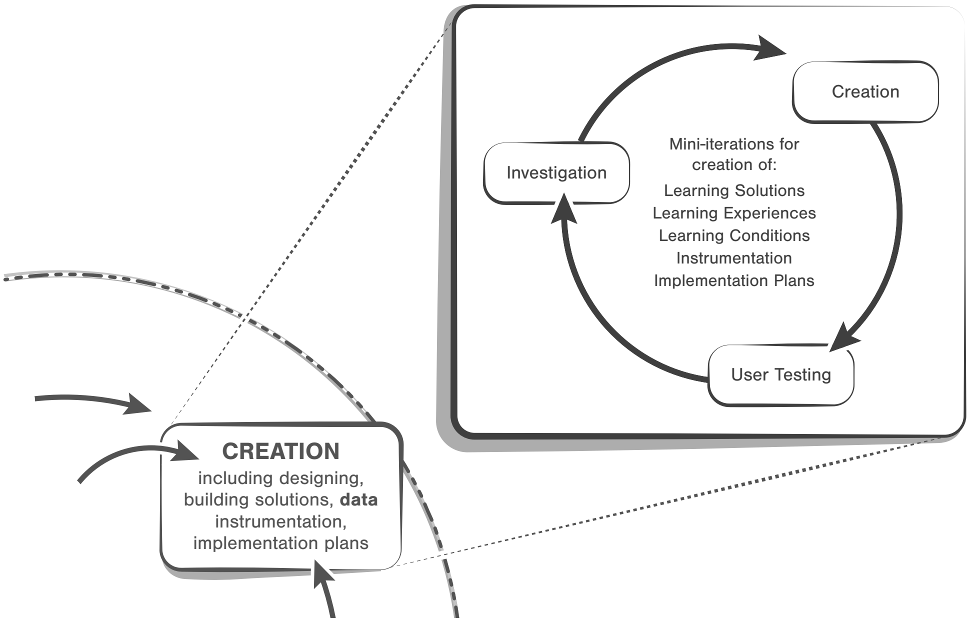

FIGURE 1.5. Learning engineering process detail: the creation cycle

process, it is often fraught with difficulties and complexity. Even at a slightly larger scale there can be complexity. For example, in a project that implemented robotics-based proportional reasoning tutoring systems, implementation and testing was done across just three different school settings with three different educators.[1] Each educator operationalized and enacted the system in a different way, leading to mixed results. Much of the complexity came from differences in the specific learning goals that each of the educators hoped to address. Implementation and testing generally become more complex in each iteration as venues and teachers or facilitators are added, requiring more focus on details of implementations and their similarities to and differences from what was expected as more variation is added. In fact, understanding how systems are implemented and the impacts of such work could be a separate learning engineering challenge that must be addressed. (See Chapter 16, Implementation Tools.) Thus, the work of understanding and accounting for the implementation during the creation (or improvement) phase of the process is critical.

Electrostatic Playground: Implementation

The first implementation involved a group of first-year physics students engaging with the system as part of their coursework. Ultimately twenty-three students participated in what the instructor called an optional part of the course that could help reinforce their understanding of electric flux and Gauss's Law. The implementation took place shortly before final exams. The students who participated in some cases had already understood the concepts well when they were initially introduced, while other students were hoping to understand these concepts more fully the second time around. Using the explanatory-exploratory structure described above, student groups engaged with each of the three learning segments and the final open-ended exploration time. The total time to complete the experience lasted around an hour, and no group went over one hour and fifteen minutes in the environment.

[6]

Investigation

Having implemented the solution and collected data, the work of processing, analyzing, and interpreting the outcome can be done. In some instances, this part of the process might begin as soon as the very first learners are done engaging with the created experience or system; in other instances, hundreds of learners will need to finish work before this part of the process can begin. Much of the analysis process will be dependent on the knowledge and skills of the team members engaged in the work. In most instances the use of qualitative, quantitative, and mixed-method approaches to data analysis are likely appropriate and each analysis will have different timelines for when actionable interpretations can be produced back to the larger team. (See Chapters 5 and 6 for more details of how data instrumentation and analysis apply to learning engineering.)

In some instances, the results can feed directly back to the implementation group to support learner engagement, while in others the results will inform the next round of design and improvement of the experience or system, and in yet other instances the results will show positive outcomes for the challenge while highlighting other challenges within the same context. It's also important to note that sometimes the results are inconclusive, unclear, or simply more data are needed to verify results. In these instances, the learning engineering team may decide to rerun the implementation without making any changes. In some instances, the team may make small adjustments based on results but keep the system mostly the same to implement with more learners or just in a new context that they believe the already designed solution will work.

[7]

Completing the Loop

Completing a loop of the learning engineering process means feeding what was learned back into other parts of the cycle to improve the work continually and iteratively. The learning engineering process is intended to allow people or teams continually and purposefully to address complex learning challenges in ways that are informed by results and improve over time. Such iterative attention to detail is critical in designing learning solutions that work as intended for the many different situations in which a solution will be implemented.

While the learning engineering process is intended to be a way to focus on the central challenge, it is likely foolish to think that only one challenge will need to be worked on at a time, especially in business or large-scale settings. Although the people and teams working on an individual learning engineering process should be highly integrated and focused on the central challenge, the reality of most settings is that a "single challenge" will be connected with or nested within dozens of

Electrostatic Playground: Data Story

Data from each of the learner sessions were captured using an approach that was fully integrated with the software. During sessions, the system captured audio from the microphone of each participant (integrated with the headset) and logged all activity within the interactive environment, including the movement of the headsets and controllers and controller-based object interactions. Using the corresponding data logs, the system could play back the entire session either in VR or on a 2D screen, including audio, for further analysis.

While the data allowed for recordings of the sessions to be played back from the perspective of each participant, the learning engineering team found it difficult to encode the data. It was challenging keep track of each participant's actions and also complicated to structure the data in a way that would allow for exploration from both single participant and multiple participant (i.e., **joint attention**) perspectives. Further, no existing data coding platform allowed for easy coding of such recording data structures (mostly due to file format limitations). As such, the learning engineering team needed to address the issue of coding the data in a manageable and useful way. The VR system developers were tasked with creating an interface that allowed the data coder to watch the playback of the session from the first-person perspective of a participant while at the same time visualizing the session from the complementary perspective of a third person or seeing another adjustable point of view that allowed the coder to understand the wider context.

Having addressed the challenges related to coding the sessions, the next step in the mixed method approach was to create a codebook. The new first-person playback system allowed for the data coders to play back each session from the point of view of each learner and code time intervals for events like object attention, attention to the other participant, joint attention to an object, and attention to the recorded lecture. The head VR developer, with the assistance of a researcher and an intern, coded segments together to iteratively identify a set of codes that could be used to obtain good inter-rater reliability. Finally, with an established codebook in hand, the researcher and intern coded each session from the perspective of each individual participant with nested connections to coded activities of other participants who were in the VR environment simultaneously.

One of the primary emergent results from the codebook development was the identification of *aha!* moments. These moments were defined by a participant verbalizing a clear understanding or breakthrough as evidenced by an *aha!* exclamation or statement of excitement around noticing or demonstrating something. Having the data coded within the platform allowed for programmatic analysis of the data, including seeking patterns of joint attention and exploration in connection with *aha!* moments. The discovery of these *aha!* moments represented a critical step toward understanding that the created solution had demonstrated a potential for addressing the stated challenge of encouraging collaborative exploration of electrostatics principles.

other challenges that may need to be simultaneously addressed in order to produce a viable result for learners. For example, in the case of Electrostatic Playground, there was a broad challenge to make electrostatics concepts more accessible and a narrower challenge to make the data easier to label. Complex challenges call for engineering mindsets, systems thinking, and modular design. In the same way, the learning engineering process is both iterative and nested. (See Chapter 4, Learning Engineering is Engineering.)

Regardless of the number of nested challenges or difficulty associated with addressing these, each part of the process continues to center and apply the learning sciences using human-centered engineering design methodologies and data-informed decision-making to support learners and their development. Ultimately, the learning engineering process allows the team to focus their attention on the challenge at hand, while the context reminds them of how this challenge can be situated within other work being done to support learners in the context that binds their work. ★

Electrostatic Playground: Closing the Loop

Two key actions became clear based on the results of the implementation and discussions among the learning engineering team. First, while the *aha!* results were promising, the overall small number of learners who engaged with the system in the first round dictated that another round of implementation should be carried out before conclusions related to effectiveness could be made. Second, while this initial data suggested strong connections between joint object attention and *aha!* moments, the learning engineering team, especially the subject-matter experts, noted a need for more purposeful data related to content learning gains of participants. This need would require additional instrumentation to collect pre-post assessments of electrostatics situated within the overall physics course structure. With these two outputs from the initial learning engineering process clarified, the next round of implementation was scheduled for the following term with the implementation of the VR system enacted as it was in the previous cycle to ensure comparability across the data.

Endnote

1 Kessler, Aaron, Melissa Boston, and Mary Kay Stein. "Exploring How Teachers Support Students' Mathematical Learning in Computer-Directed Learning Environments." *Information and Learning Sciences 121,* no. 1/2 (2019): 52–78. https://doi.org/10.1108/ILS-07-2019-0075

- A process defines how work is done. Processes have inputs, process steps, and outputs.
- The learning engineering process can be generalized: it starts with understanding the challenge within a context, and then it includes cycles of creation, implementation, and investigation.
- The process is iterative and includes multiple passes.
- Challenges that need to be solved using the learning engineering process are often complex and require a multifaceted learning engineering team to address them.
- The learning engineering process starts by understanding the challenge in context, but after that, the next steps may vary. Different teams will have different journeys through it, depending on their challenge and its contextual factors. The challenge may call for creation of a new learning experience, adjustments to the implementation of an existing learning solution, or additional data analyses as part of the investigation phase.
- Learning engineering processes used by a large team may be different from those used by a small one, and the processes for developing one kind of experience (for example, a training simulation) may be different from those used for designing a different activity (such as a secondary school curriculum).
- Learning engineering challenges, as well as the processes used to address them, often have sub-challenges or require sub-processes that need to be considered concurrently.
- Processing, analyzing, and interpreting the data from an implementation of a learning experience is necessary to inform the next iterative cycle of the learning engineering process.

LEARNING ENGINEERING IS A PROCESS

KEY POINTS

UNDERSTAND