Educational Technology and the Scholarship of Teaching and Learning: Asking Questions about our Practices

Lauren Hays; Janice Miller-Young; and Brett McCollum

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Preface

LAUREN HAYS; BRETT MCCOLLUM; AND JANICE MILLER-YOUNG

The role of educational technology in higher education has expanded to its current state of ubiquity. Yet the COVID-19 global pandemic, beginning in 2020, revealed the necessity of developing an increased understanding of how modern technologies are, can be, and should be used to best support student learning. SoTL scholars have spent the past few years asking important questions about the opportunities, barriers, challenges, and ethics of educational technology use during this time of uncertainty, as well as drawing upon established areas of research on related topics such as online education.

We (the editors) believe that now is a good time to pause, reflect on the use of technology in higher education, and pull together insights from multiple areas of scholarship and practice to ask new questions:

- What does the literature tell us about the impact of technology on learning, learning experiences, and learning environments?
- What technology-supported strategies should we keep in our classes?
- What technology-supported strategies do we no longer need?
- What learning opportunities are created or enhanced through the use of technology and generative Artificial Intelligence?
- How can we address issues of equity and technology access that have been raised by using technology in our teaching environments?

The chapters in this book do not answer all these questions, but they provide examples of how SoTL can be used to do so.

When we first met to discuss the vision for this book, we started by looking for other sources that discussed SoTL and educational technology. We quickly realized that a gap exists in this area due to little published work on this topic. Therefore, this book is intended to serve as a foundational text on educational technology and SoTL and aims to support both educators and SoTL scholars in (re)examining their practices through a scholarly lens.

Our primary goal for this book was to fill a gap in the SoTL literature related to educational technology. SoTL emphasizes teaching and learning within a higher education setting. It also involves a diverse community of researchers—e.g., english literature, business, engineering, and nursing—who come with their disciplinary research methodologies, traditions, and contextual problems they aim to address using educational technology. The unique approach of this book is that it emphasizes the range of research approaches used by SoTL scholars to investigate the efficacy, implications, and possibilities afforded by educational technology.

Once the gap was identified, we sent a call for proposals to solicit chapters in the areas of theory, designing and conducting SoTL on educational technology-supported practices, and scholarly teaching with educational technology. We received numerous proposals and selected chapters based on our vision for the book and how they aligned with the three categories. We also wanted a diverse set of scholars involved in the book, as SoTL is an international movement.

This book includes three sections:

1. SoTL Foundations
2. Reflections on Methodologies and Methods
3. Research and Scholarly Reflections on Educational Technology

SoTL Foundations focuses on establishing our vision for the incorporation of theory and a focus on methodological design when conducting SoTL work on educational technology. The fifth chapter in this section focuses exclusively on theory and provides an example of how theory impacts the questions we ask about educational technology in our teaching and students' learning.

Reflections on Methodologies and Methods examines the methods and methodologies used in SoTL work. The chapters include examples of qualitative and quantitative research and include reflections from the authors about the lessons they learned from designing a SoTL study focused on educational technology.

Scholarly Reflections on Educational Technology focuses on reflections authors have about their use of educational technology for teaching and learning. Chapters include reflections on how they developed projects, how they used educational technology in their classes, and lessons learned. This section includes examples from different subject areas and examples of different types of educational technology. What holds this section together is the focus on using educational technology to improve teaching and learning.

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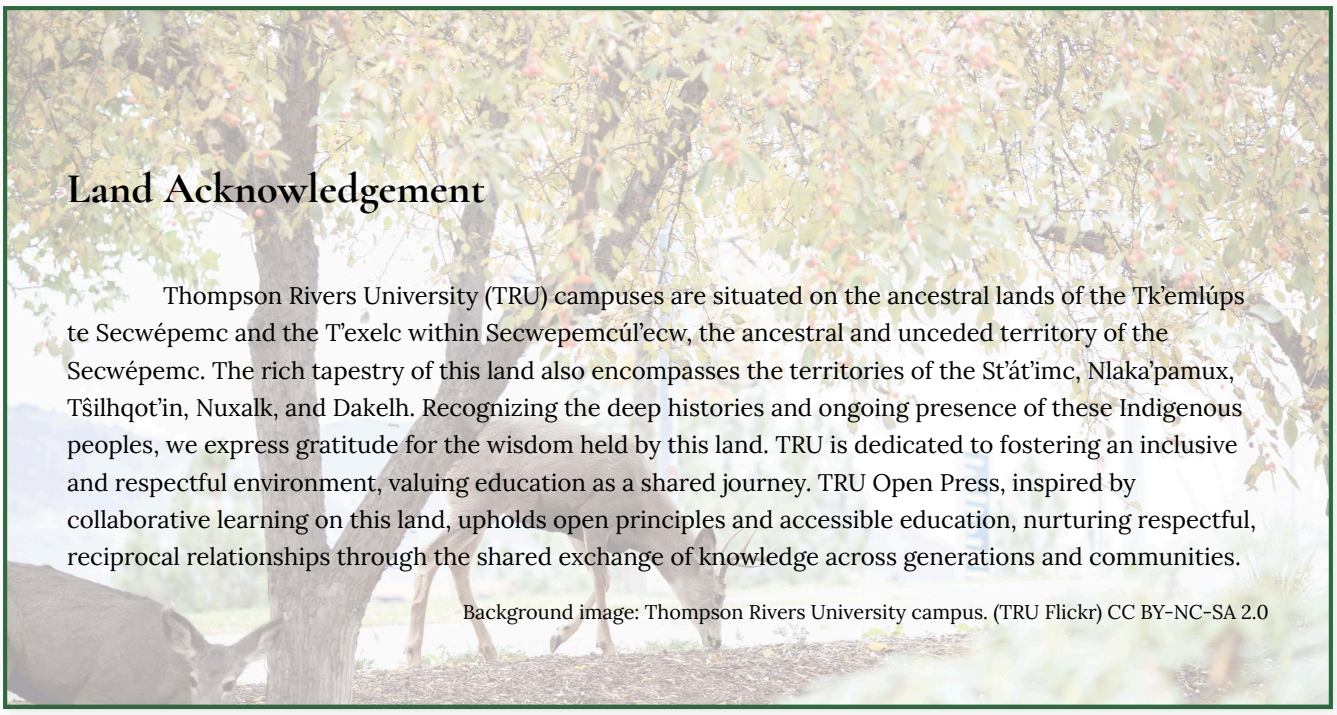

Land Acknowledgement

Thompson Rivers University (TRU) campuses are situated on the ancestral lands of the Tk'emlúps te Secwépemc and the T'exelc within Secwepemcúl'ecw, the ancestral and unceded territory of the Secwépemc. The rich tapestry of this land also encompasses the territories of the St'át'imc, Nlaka'pamux, Tŝilhqot'in, Nuxalk, and Dakelh. Recognizing the deep histories and ongoing presence of these Indigenous peoples, we express gratitude for the wisdom held by this land. TRU is dedicated to fostering an inclusive and respectful environment, valuing education as a shared journey. TRU Open Press, inspired by collaborative learning on this land, upholds open principles and accessible education, nurturing respectful, reciprocal relationships through the shared exchange of knowledge across generations and communities.

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PART I

SECTION I: SOTL FOUNDATIONS

This section serves two key purposes. First, it establishes philosophical, methodological, and theoretical foundations for exploring the role of educational technology in SoTL research. Second, it demonstrates how philosophical concepts—particularly Arendt's notions of plurality, promise, and forgiveness—can shape the questions we ask and the approaches we take when studying technology-enhanced teaching and learning.

During the initial brainstorming for this book, we (the editors) knew we wanted to focus on SoTL and educational technology. A concern that frequently arose was how studies on educational technology often emphasize the technology itself rather than the teaching and learning it enables. To address this, we wrote three foundational chapters designed to help readers engage with and develop their own SoTL studies on educational technology while maintaining a focus on teaching and learning.

In **Chapter 2: Research Paradigms and Methodologies for Pedagogical Research**, Janice Miller-Young discusses how to develop a SoTL study on educational technology that centres on teaching and learning rather than the tools themselves. She emphasizes that it is important to know "the breadth of types of research questions and associated research paradigms, methodologies, and theories that can be useful to a SoTL researcher" and maps a variety of example SoTL studies to relevant paradigms and methodologies.

In **Chapter 3: Aligning Theoretical Frameworks with SoTL Research Questions Focused on Technology**, Lauren Hays outlines commonly used educational theories and lists examples of how those theories influence the types of research questions we ask in SoTL. We (the editors) believe SoTL researchers benefit from being aware of their theoretical assumptions about learning "because it will help them ask new questions, design better studies, and also more strongly articulate their findings" (Miller-Young & Yeo, 2015, p. 40).

In **Chapter 4: Communicating our SoTL to Support Scholarly Teaching**, Brett McCollum explains how to communicate SoTL research on educational technology effectively. Specifically, he explains why it is important to keep the focus on teaching and learning when discussing educational technology in SoTL research, and then provides examples of how to do that. The chapter ends with a challenge: Readers are encouraged to review sample research questions and reframe them to emphasize the teaching and learning enabled by educational technology.

In **Chapter 5: Plurality, Promise, and Forgiveness as Philosophical Foundations for SoTL Projects in Educational Technology Contexts**, Alice Watanabe demonstrates how political theory can be used as a lens from which to view our SoTL work. Using the work of political theorist Hannah Arendt, she describes how Arendt's work can form the foundation of a SoTL project specifically in the area of educational technology. This chapter inspires us to embrace interdisciplinary collaboration, critically examine the ethical and social dimensions of technology-enhanced learning, and incorporate reflective, trust-based pedagogical approaches to foster inclusive and adaptive teaching practices.

Together, these chapters provide a foundation for conducting SoTL research on educational technology. By addressing research paradigms, theoretical frameworks, effective communication, and philosophical perspectives, this section equips readers with diverse tools and perspectives for reflecting on their teaching and designing meaningful studies that move beyond the technology itself.

References

Miller-Young, J., & Yeo, M. (2015). Conceptualizing and communicating SoTL: A framework for the field. *Teaching and Learning Inquiry*, 3(2), 37–53. https://doi.org/10.20343/teachlearninqu.3.2.37

1. Framing the Possibilities: Educational Technology and SoTL in Action

LAUREN HAYS; BRETT MCCOLLUM; AND JANICE MILLER-YOUNG

The role of educational technology in higher education has expanded to its current state of ubiquity. Yet, the COVID-19 global pandemic beginning in 2020 revealed the necessity of developing an increased understanding of how modern technologies are, can, and should be used to best support student learning. Additionally, the rapid development of artificial intelligence tools has placed technology at the forefront of many educator's minds. Scholars of teaching and learning have spent the past few years asking important questions about the opportunities, barriers, challenges, and ethics of educational technology use during this time of uncertainty, as well as drawing upon established areas of research on related topics such as online education.

We (the editors) believe now is a good time to pause, reflect on the use of technology in higher education, and pull together insights from multiple areas of scholarship and practice in order to ask new questions. As Luehrmann originally argued in 1971 (2022) argued long before technology was ubiquitous in higher education, technology needs to be seen "as an intellectual tool with applications to the subject matter being taught" (para. 31) and not solely as an add-on. This leads to questions such as, what does the literature tell us about the impact of technology on learning, learning experiences, and learning environments? What technology-supported strategies should we keep in our classes? What technology-supported strategies do we no longer need? What learning opportunities are created or enhanced through the use of technology? How can we address issues of equity and technology access which have been raised by remote or online teaching environments? The chapters in this book don't answer all these questions, but they provide exemplars of how the Scholarship of Teaching and Learning (SoTL) can be used to do so.

SoTL is broadly understood as pedagogical research conducted in the higher education context and/or a venue for educators to reflect on their practices. Conducted by higher ed instructors themselves, this form of inquiry creates, by definition, a multidisciplinary field which consists of multiple disciplinary and multidisciplinary communities within a landscape of practice (Miller-Young 2024). In other words, SoTL may be conducted by an instructor from any discipline and they may bring their disciplinary research methodologies, traditions, and contextual problems to the research. Also, they may choose to disseminate to either a disciplinary or multidisciplinary audience, depending on the nature of their findings and where they might have the most impact beyond their own teaching practice. Traditional educational research on educational technology, on the other hand, is either approached through the lens of education using social science methods or approached using quantitative methods based in the sciences and typically disseminated to others in the field of education, and unfortunately, there is often a lack of rigorous research beyond the educational technology products themselves (Digital Promise, 2015; Keiding & Qvortrup, 2018). The unique benefit of SoTL is that it can have an immediate impact on the instructor's teaching practice. The unique approach of this book is that it emphasizes the range of research approaches used by SoTL scholars to investigate and envision the efficacy, implications, and possibilities afforded by educational technology.

We, the editors, have diverse and complementary areas of expertise when it comes to these topics. Lauren Hays is an associate professor of educational technology and has focused much of her teaching and research on practitioner approaches to using technology effectively in education. Brett McCollum has explored SoTL as a meeting place for scholars of diverse disciplinary traditions and as a scholarly community that celebrates methodological pluralism while maintaining disciplinary traditions of methodological rigour. Janice Miller-Young has focused a major portion of her work on exploring SoTL methodologies and the experiences of faculty learning to do SoTL. When we first met to discuss the vision for this book, we started by looking for other sources that discussed SoTL and educational technology. We quickly realized that a gap exists in this area and there was little published on this topic. Therefore, this book is intended

to serve as a foundational text on educational technology and SoTL, and aims to support both educators and SoTL scholars in (re)examining their practices with a scholarly lens.

Our primary goal for this book is to fill a gap in the SoTL literature related to educational technology. The higher education literature includes many studies where researchers have studied the use of various educational technology tools in classrooms, but literature on how SoTL scholars should think about their use of educational technology or study their use of educational technology does not exist. Once the gap was identified, we sent a call for proposals to solicit chapters in the areas of theory, designing and conducting SoTL on educational technology-supported practices, and scholarly teaching with educational technology. We received numerous proposals and selected chapters based on our vision for the book and how they aligned with the three sections we outline below. We accepted research articles as well as other genres of SoTL, including conceptual articles and scholarly and reflective essays (Miller-Young & Chick, 2024). We also wanted a diverse set of scholars contributing to the book, as SoTL is an international movement. Authors come from six countries and work in disciplines ranging from history to statistics.

This book includes three sections: SoTL Foundations, Reflections on Methodologies and Methods, and Research and Scholarly Reflections on Educational Technology. From beginning to end, we take the position that no research question or method is better or worse than another, but that all SoTL research benefits from explicit alignment and communication of questions, methodology, and theory. Thus, before diving into the rest of this book, we recommend developing a basic understanding of the breadth of types of research questions and associated research paradigms, methodologies, and theories that can be useful to a SoTL researcher by reading the foundational chapters. SoTL Foundations focuses on the importance of methodological design, theory and communication when conducting SoTL work on educational technology. The fourth chapter in this section is focused exclusively on theory and provides an example of how theory impacts the questions we ask about educational technology in our teaching and students' learning. Next, the section Reflections on Methodologies and Methods is focused on the methods and methodologies used in SoTL work. The chapters include examples of qualitative and quantitative methods and include reflections from the authors about the lessons they learned from designing a SoTL study focused on educational technology. The final section, Scholarly Reflections on Educational Technology, focuses on reflections authors have about their use of educational technology for teaching and learning. Chapters include reflections on how they developed projects, how they used educational technology in their classes, and lessons learned. This section includes examples from different subject areas and examples of different types of educational technology. What holds this section together is the focus on using educational technology to improve teaching and learning.

By emphasizing the importance of aligning research questions, methodologies, and theories in SoTL work, this book not only contributes to the existing body of knowledge but also provides a path for future SoTL research in educational technology. It invites readers to reflect on their own practices, engage in scholarly inquiry, and contribute to the ongoing dialogue about the role of technology in shaping the future of higher education

References

Luehrmann, A. (2002). Should the computer teach the student, or vice-versa? *Contemporary Issues in Technology and Teacher Education*, *2*(3), 389–396. https://citejournal.org/volume-2/issue-3-02/seminal-articles/should-the-computer-teach-the-student-or-vice-versa/

Keiding, T. B., & Qvortrup, A. (2018). Higher education journals as didactic frameworks. *Higher Education Research & Development*, *37*(1), 72–87. https://doi.org/10.1080/07294360.2017.1342606

Miller-Young, J. (2024). Complex journeys and theory as scaffolding: An illustrated guide to the SoTLscape. In J.

Miller-Young & N. L. Chick (Eds.), *Becoming a SoTL scholar*. Elon University Center for Engaged Learning. https://www.centerforengagedlearning.org/books/becoming-a-sotl-scholar/section-3/chapter-13/

Miller-Young, J. & Chick, N.L. (2024). Developing sustained SoTL journeys and identities. In J. Miller-Young & N. L. Chick (Eds.), *Becoming a SoTL scholar*. Elon University Center for Engaged Learning. https://www.centerforengagedlearning.org/books/becoming-a-sotl-scholar/chapter-1/

2. Research Paradigms and Methodologies for Pedagogical Research

JANICE MILLER-YOUNG

Introduction

All research begins with a question, problem, or topic of interest. The process of transforming broad classroom issues and interests into precise SoTL research questions is an iterative and reflective process. It involves a thorough literature review, a deep understanding of context, and careful consideration of personal interests, experiences, and available resources. In other words, it can be a complex process, and sometimes it is hard to know where to begin. Before writing a research question, it can be helpful to step back and familiarize yourself with the range of types of research questions that can be asked—in other words, to think in terms of paradigms and methodologies. When researching educational technology in a SoTL context, these foundational concepts will not only help you explore and reflect on different types of research questions but also help you maintain the focus of your research on teaching and learning, rather than on the technology itself. While it is not (yet) common for SoTL researchers to state their paradigm or methodology explicitly (Divan et al., 2017; Haigh & Withell, 2020), we strongly recommend it in this book because it will also help you to a) build a well-designed study and b) increase the impact of your work. Also, many funders and journals require it because it helps you c) better communicate your study to a multidisciplinary audience. This chapter aims to offer a concise introduction to common educational research paradigms and methodologies that are useful for SoTL research.

As an instructor trained in a particular discipline or profession, you hold underlying philosophies and theories about knowledge and how it is constructed—which you may or may not have thought about explicitly, depending on your discipline. For example, in high consensus fields, such as natural sciences and engineering, knowledge is generally seen as accumulating over time—with new studies building on previous ones and branching out into new layers of detail and complexity, like the branches of a tree (Becher & Trowler, 2001). This perspective makes sense for studying the natural world, which most researchers would describe as existing independently of us as humans (although this can still be debated, even in physics!). Researchers from high consensus fields therefore tend to have less experience articulating their philosophies about the nature of knowledge and reality. There tends to be an accepted, dominant paradigm which needs no explanation within their disciplinary community of practice. Studying teaching and learning, however, is much more complex in terms of how it may draw upon many different philosophies and conceptualizations about knowledge, learning, and the nature of "reality." This complexity, coupled with the multidisciplinary nature of the SoTL landscape, necessitates that researchers be much more explicit about their thinking when presenting their work. In the social sciences, researchers frequently employ the notions of paradigms and methodologies to describe their research.

Research Paradigms

Every research endeavour is grounded in underlying philosophical assumptions, whether these are explicitly articulated or not. These assumptions shape how we formulate and investigate research questions and can be described as a paradigm (**Figure 2.1**). Philosophers and research methodologists tend to classify research paradigms using three philosophical concepts which are intimately linked:

- the researcher's worldview, or perspectives on the nature of reality (ontology)
- how the researcher understands things to be known (epistemology)
- the values driving the research (axiology).

Philosophical and methodological debates in research literature, often referred to as the "paradigm wars," emerged in the latter half of the 20th century. During this period, qualitative researchers championed their approaches against the prevailing Euro-Western paradigms of positivism and post-positivism, while feminist scholars, including those in science and engineering, began to challenge the concept of objectivity in scientific inquiry (Morgan, 2007). These debates persist, and new methodologies are continually emerging and evolving. Thus, the categories outlined here are broad brushstrokes that serve as a guide for positioning oneself within a diverse landscape of practice; however, they are neither perfectly delineated nor exhaustive. Additionally, one should be aware that some of the terms we use below may be defined or applied differently in other discourses.

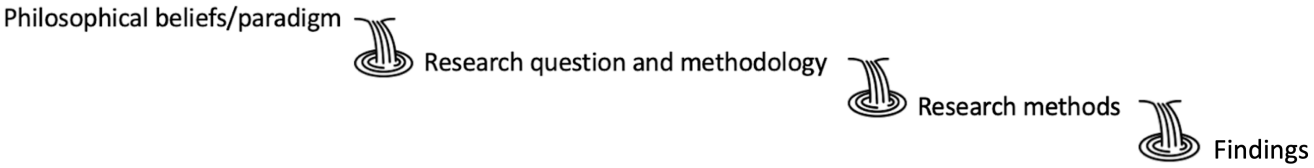

Figure 2.1 *A researcher's philosophical beliefs and assumptions result in a cascade of decisions to be made in designing a research study, including choice of research question, methodology, and methods, all of which will influence the findings (waterfall image CC BY 4.0).*

Positivism

According to Kara's (2022) historical review, "up to the 1960s research was almost exclusively positivist" (p. 9). Positivist research questions focus on finding predictable and replicable cause-effect relationships that can be used to predict subsequent events and/or generalize across contexts. In other words, they are concerned with building knowledge by testing and refining theory and hypotheses. In this paradigm, a single, observable reality is assumed, and theory provides the explanatory framework that relates the concepts or variables being studied, although the researcher may or may not explicitly state their theory. Knowledge is viewed as cumulative, often leading researchers to identify questions based on gaps in the existing literature. Even smaller, context-specific studies, such as those commonly found in the SoTL literature, can contribute meaningfully within this paradigm, as their findings can be aggregated through meta-analysis. Quantitative experimental research designs, and much research from the natural sciences and some areas of psychology, would fit within this paradigm.

Neo-positivism

The definition of post-positivism or neo-positivism emerged somewhat later. This view recognizes that reality can only ever be partially known or understood because all research has limitations (e.g., biases, accuracy of measurements). As a result, studying cause and effect can only be based on probability. However, researchers within this paradigm still seek to understand a single, external reality through observation and aspire to impartiality and objectivity. Given that phenomena cannot be isolated from context, most quantitative SoTL studies would fit within this category. Empirical qualitative approaches, both deductive and inductive, also fit here. Examples include phenomenography (**Chapter 8**), template analysis (deductive), content analysis (inductive), and empirical thematic analysis (Yeo et al., 2023). For example, qualitative coding approaches that check for inter-rater reliability fall within this paradigm because of their

assumption of a single reality. We put **Chapters 7** and **11** in this category because they apply a relatively transparent lens to their analysis, and the former checks for inter-rater reliability.

Critical Realism (an "Intermediate") Paradigm

There is a substantial gap between positivism and interpretivism. Paradigms that fill this gap do not try to isolate the phenomenon of interest from its context; they explicitly build, refine, or extend theory (rather than test hypotheses) and acknowledge the socially constructed nature of theory. One notable intermediate paradigm that is potentially valuable for SoTL research is critical realism (Miller-Young, 2025). One notable intermediate paradigm that is potentially valuable for SoTL research is realism, a common branch of which is called critical realism (Miller-Young, 2025). This approach focuses on providing contextual and stratified explanations of phenomena; in other words, it asks "why" and "how" questions. The world is viewed as having different layers of reality which are independent of the researcher: the empirical (what can be observed, such as students performing a task); the actual (processes and events, such as student behaviours or decisions); and the real (students' underlying beliefs or prior conceptions), which result from a combination of "causal mechanisms" (Brown, 2009; Mingers, 2014). In other words, learning is understood as a phenomenon that results from multiple causal mechanisms and can be studied at different levels such as physical, biological, psychological, social, and curricular (Miller-Young, 2025).

In contrast to the natural sciences, social systems are inherently complex and cannot be studied in isolation. Consequently, researchers must depend on abstraction and conceptualization, making explicit use of theoretical frameworks to understand these complexities. Causation, therefore, is not something that can be studied by isolating variables, nor is it expected to be measurable and replicable across multiple contexts. Rather, causation is explained by identifying *how*, *why*, *and under what conditions* causal mechanisms work. Put another way, because of the acknowledgement of complexity, the goals in this paradigm are to explain and anticipate phenomena, rather than to predict. The "critical" aspect of critical realism derives from three features: the recognition that all theories are social constructions; the need for critical self-reflexivity in the research process; and critical realism's emancipatory potential, based on its aim to identify causal processes, knowledge of which can then inform action (Mingers 2014).

Compared to positivism and interpretivism, this category of paradigms is best defined by its systems ontology. It is also compatible with a broad range of research methodologies, including mixed methods. Paradigms in this category require that researchers practice reflexivity, which involves a keen awareness of their own position relative to the phenomenon under study. Researchers must also continuously reflect on the social, historical, and cultural influences that shape their selection of research questions, theoretical frameworks, and methods. As an example in this book, **Chapter 9** uses netnography, a type of ethnographic research conducted online, and positions the learner not as independent from technology but rather as a collaborator with it.

Interpretivism

Researchers using an interpretivist paradigm seek to enrich our understanding of social or cultural events based on the perspectives and experiences of the individuals or groups being studied (Braun & Clarke, 2013). Interpretive researchers view reality as something we, as humans, are a part of, and which therefore cannot be studied independently of us. Rather, they value the researcher's closeness to the phenomenon being studied and embrace the inevitable subjectivity. Interpretive research therefore involves the generation of qualitative materials for analysis, such as interview transcripts, with the researcher acknowledging that they play an active role in co-constructing the data with participants. These researchers would also describe their positionality and reflexivity as part of the knowledge

production process, recognizing that there are varied and multiple meanings that could describe participants' experiences. Interpretive researchers typically use theory to situate their work within a body of literature but leave it to the reader to determine the transferability of their findings to other contexts. They therefore provide a rich description of the study context. Some research from the social sciences, and much from the humanities, would fit within this paradigm. While not an empirical investigation, we suggest **Chapter 5** best fits in this category because it is concerned with meaning-making, plurality, and subjective experiences in education.

Transformative

Transformative methodologies are explicit about causing change through the nature of the research approach itself as well as the knowledge it produces. They aim to expose and reduce power imbalances by collaborating with, rather than conducting research on, marginalized groups. As Creswell and Poth (2018) explain, "the basic tenet of this transformative framework is that knowledge is not neutral and it reflects the power and social relationships within society" (p. 25). A number of research approaches fit within this broad category, including feminist theory, critical race theory, and participatory approaches such as participatory action research and Students-as-Partners (SaP) (Mercer-Mapstone et al., 2017). Researchers using transformative methodologies need to "reflect on their own power and how they use it, as well as the shifting balances and imbalances of power within and beyond the research team" (Kara, 2022, p. 31).

Transformative research is inclusive of a range of methodologies in terms of epistemology and ontology, and is best delineated by its axiology and participatory nature. In this book, **Chapter 10** takes a multi-method, empirical approach in terms of methodology and a transformative approach in terms of collaborating with students in all stages of the research process. **Chapter 8**, on the other hand, demonstrates an interpretive approach to research while also working with students as partners in teaching and learning.

Table 2.1 A *Heuristic of Common Research Paradigms and Associated Philosophical Beliefs*

Category	**Nature of Reality (Ontology)**	**Nature of Knowledge and How It Is Known (Epistemology)**	**Roles of Values/Drivers (Axiology)**
Positivism	There is an external reality which exists independently from people	Knowledge builds based on empirical observations	Researcher values objectivity and attempts to control for bias
Neo-positivist (Deductive)	Reality is shaped by patterns that emerge within specific contexts	Knowledge is based on established theories and prior evidence	Researcher values objectivity, neutrality, and value-free inquiry
Neo-positivist (Inductive)	Reality is shaped by patterns that emerge within specific contexts	Knowledge is constructed and provisional	Researcher values objectivity and strives to minimize researcher influence
Intermediate (Critical Realism)	There is a stratified, external reality but it is inseparable from context	Knowledge is socially and historically produced	Researcher values objectivity but also acknowledges their positionality
Interpretivism	Reality does not exist independent of people; people interpret facts and phenomena	Knowledge comes from co-constructing meaning from experience	Researcher values subjectivity
Transformative	People experience multifaceted realities influenced by their social location	Knowledge comes from co-constructing meaning	Researcher seeks social justice through emancipatory and collaborative processes

Note. Adapted from Ling (2019), Miller-Young (2025), and Yeo et al. (2023)

Research Methodologies

As Miller-Young and Yeo (2015) explain, research methodologies are more than simply a "description of how the participants were selected, and the data collected and analyzed. Methodology explains why it was done this way" (p. 42), aligning the philosophical assumptions of the research with the methods employed and demonstrating how theory frames and informs the study. In this next section, we briefly describe a few broad categories of methodologies and refer the reader to Yeo et al. (2023) for more detailed descriptions of both methodologies and methods.

Quantitative Research Methodologies (Designs)

Quantitative research, as its name suggests, relies on numerical data and measurements. The aim is to simplify complexity and identify patterns within large datasets, employing a deductive approach where theory and literature precede data collection. Theory guides the formulation of hypotheses and informs decisions on which variables to measure and control. Because there is no possibility for further interpretation once the data is collected, quantitative research requires a substantial amount of work upfront to ensure that measurements are valid, reliable, and repeatable. It must also ensure that a study will have statistical power; in other words, that the measurements are meaningful and that the statistical findings are likely not due to random chance.

Common quantitative educational research designs and the types of questions they ask include (quasi-)experimental designs (*What is the effect/impact of x on y?*), correlational designs (*What is the relationship between x and y?*), and survey designs (*How are certain variables/characteristics distributed within a population?*). Depending on the phenomena being studied and the use of theory and/or participatory methods, quantitative studies may fall within the positivist, neo-positivist, critical realist, or transformative paradigms.

Qualitative Methodologies

Although educational technology research has often been characterized by a dominance of quantitative methods, qualitative research holds significant potential for addressing the complex challenges that educational technologies seek to overcome (Henrich, 2024). The purpose and value of qualitative research lie in its capacity to explore complex phenomena in depth. Qualitative methodologies are highly diverse, drawing on various epistemologies, ontologies, and axiologies (Tracy, 2010). They can be both inductive and deductive, accommodate different degrees of researcher objectivity or subjectivity, and use materials such as interview and focus group transcripts, narratives, documents, and photographs as data sources. Theory may serve both as an orientation to the research and a lens for data analysis.

When using what are often called "qualitative empirical" (Miller-Young & Yeo, 2015; Yeo et al., 2023) or "small q" approaches (Braun & Clarke, 2013), researchers use a relatively transparent lens, taking the data at face value and assessing the trustworthiness of their findings through processes such as triangulating multiple sources of data, determining inter-coder reliability, and member checking. Such studies would fit within a neo-positivist or critical realist paradigm. Phenomenography and case study are the most common examples (case studies can involve triangulating both quantitative and qualitative data, but still take an overall qualitative approach to the research compared to mixed methods; see below).

Interpretive qualitative research (or "big Q" [Braun & Clarke, 2013]) is more commonly used when studying

culture and experiences. The researcher acknowledges the important role of both the context of the research and the co-constructed nature of the resulting knowledge. Trustworthiness and "generalizability" are addressed differently in this paradigm because of the co-constructed nature of knowledge. Criteria for quality research include thick description, triangulation, and resonance (Tracy, 2010). Examples of interpretive methodologies include ethnography (for questions about culture), narrative inquiry (for making meaning from people's stories), and phenomenology (for questions about the essence of experience). Grounded theory is another qualitative, interpretive methodology that is explicitly inductive and used for building new theory.

Mixed Methodologies

True Mixed Methods (big M) research presents valuable opportunities for SoTL researchers by integrating the broad insights of quantitative research with the deep understanding of qualitative research. However, it demands a broader range of expertise, necessitating proficiency in both quantitative and qualitative methodologies. To be clear, the methodological category of "Mixed Methods," despite the unfortunate name, involves more than simply collecting quantitative and qualitative data (better described as multi-method or case study, as noted above). It is defined by having a quantitative component (that meets the standards for quantitative research, such as statistical power) and a qualitative component (that meets the standards for qualitative research) as well as by integrating the findings from both components in order to derive insights that could not be found using qualitative or quantitative methods alone.

Given its integration of diverse qualitative and quantitative traditions, some argue that Mixed Methods research constitutes its own paradigm, often referred to as pragmatism (Morgan, 2007). Nevertheless, the quantitative and qualitative elements within a Mixed Methods study usually maintain their distinct philosophical approaches and assumptions, as outlined previously. Components of a study can be conducted sequentially or concurrently. Mixed Methods studies are also highly compatible with critical realism (Yeo et al., 2023).

Aligning your underlying philosophical assumptions with your research questions, paradigms, and methodologies is essential for developing and conducting an effective SoTL research study. By making these choices explicit, you strengthen the design and coherence of your work, and improve your ability to communicate its significance and impact to interdisciplinary audiences.

The next chapter will expand on how theory can also play an important role in SoTL.

Reflective Questions

- What are the epistemologies, ontologies, and axiologies of your discipline?
- What research paradigms are you most comfortable with in terms of informing your teaching and research practice?
- What research paradigms are you most comfortable with in terms of conducting your own SoTL research?
- How do you position yourself in your research?
- How do you communicate your philosophical beliefs and values to others?

References

Braun, V., & Clarke, V. (2013). *Successful qualitative research: A practical guide for beginners*. Sage.

Brown, G. (2009). The ontological turn in education: The place of the learning environment. *Journal of Critical Realism*, 8(1), 5–34. https://doi.org/10.1558/jocr.v8i1.5

Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches*. Sage.

Divan, A., Ludwig, L. O., Matthews, K. E., Motley, P. M., & Tomljenovic-Berube, A. M. (2017). Survey of research approaches utilised in the scholarship of teaching and learning publications. *Teaching and Learning Inquiry*, 5(2), 16–29. https://doi.org/10.20343/teachlearninqu.5.2.3

Haigh, N., & Withell, A. J. (2020). The place of research paradigms in SoTL practice: An inquiry. *Teaching & Learning Inquiry*, 8(2), 17–31. https://doi.org/10.20343/teachlearninqu.8.2.3

Kara, H. (2022). *Qualitative research for quantitative researchers*. Sage.

Ling, L. (2019). The power of the paradigm in scholarship in higher education. In *Emerging methods and paradigms in scholarship and education research*. IGI Global.

Mercer-Mapstone, L., Dvorakova, S. L., Matthews, K. E., Abbot, S., Cheng, B., Felten, P., Knorr, K., Marquis, E., Shammas, R., & Swaim, K. (2017). A systematic literature review of students as partners in higher education. *International Journal for Students as Partners*, 1(1), 15–37. https://doi.org/10.15173/ijsap.v1i1.3119

Miller-Young, J., & Yeo, M. (2015). Conceptualizing and communicating SoTL: A framework for the field. *Teaching and Learning Inquiry*, 3(2), 37–53. https://doi.org/10.20343/teachlearninqu.3.2.37

Miller-Young, J. (2025). Asking "how" and "why" and "under what conditions" questions: Using critical realism to study learning and teaching. *Teaching and Learning Inquiry*, 13. https://doi.org/10.20343/teachlearninqu.13.40

Mingers, J. (2014). *Systems thinking, critical realism and philosophy: A confluence of ideas*. Routledge.

Morgan, D. L. (2007). Paradigms lost and pragmatism regained: Methodological implications of combining qualitative and quantitative methods. *Journal of Mixed Methods Research*, 1(1), 48–76. https://doi.org/10.1177/2345678906292462

Pawson, R., & Tilley, N. (1997). *Realistic evaluation*. Sage.

Tracy, S. J. (2010). Qualitative quality: Eight "big-tent" criteria for excellent qualitative research. *Qualitative Inquiry*, 16(10), 837–851. https://doi.org/10.1177/1077800410383121

Yeo, M., Miller-Young, J., & Manarin, K. (2023). *SoTL research methodologies: A guide to conceptualizing and conducting the Scholarship of Teaching and Learning*. Routledge. https://doi.org/10.4324/9781003447054

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3. Aligning Theoretical Frameworks with SoTL Research Questions Focused on Technology

LAUREN HAYS

Introduction

SoTL research questions explicitly seek to understand teaching and learning in context. The oft-cited Hutchings (2000) typology of SoTL questions, including "What is" and "What works," could be described as evaluation-type questions. In other words, an instructor may seek to evaluate their teaching by describing a particular learning phenomenon that occurs in their class (what is happening?), or assess the effectiveness of a teaching strategy or intervention (what works, or what works better?). However, disseminating our inquiries as scholarship requires us to go beyond description to analysis and interpretation, and to situate our findings within a particular literature or discourse, thereby contributing to a broader understanding of how or why something is happening or working (or not). As Ciccone (2018) argues, a good SoTL question "shows the potential to go beyond the problem from whence it arose to elucidate some key insights into the big issues about student learning and the frameworks that would explain them" (p. 2018). Fortunately, there are many other fields, including but not limited to the field of (K–12) educational research, which have developed language, definitions, and frameworks to help us communicate and connect our research approaches and findings to broader issues and understandings. This is where theories about knowledge and learning can play a role.

Educational theories are a set of principles that shape how we create curriculum, employ pedagogy, interact with our students, and frame research questions. As educators, our perspectives are shaped by the theories we subscribe to, and impact how we use technology in the classroom. The lens through which we develop curriculum also shapes the questions we ask about educational technology in our teaching and learning. Miller-Young and Yeo (2015) describe how some categories of learning theories tend to fit well with certain research methodologies. In this section, we briefly explore a few key theories and consider how they may influence our SoTL work, specifically related to technology. The examples in this section are just that—examples. They are meant to provide framing for developing your own SoTL studies on educational technology grounded in theory.

Connecting Learning Theories to Educational Technology

Behaviourism

The first theory we will address is behaviourism. Behaviourism focuses on how a setting impacts a person's actions. In other words, "The goal of behavioristic teaching methods is to manipulate the environment of a subject… in an effort to change the subject's observable behavior" (Brau, 2018, para. 1). Many psychologists have worked on behaviourism including Pavlov and Skinner. While not all aspects of behaviorism are widely used today, there are still elements that educators incorporate into classes and may unknowingly use with educational technology. For example, in a classroom, the teacher may use a visual on a presentation slide to remind students that certain content is particularly important. The teacher may use music to help students stay calm before an exam, or, when a student gets a question

correct during a review session, they may be rewarded with fireworks on the screen. These are examples of positive reinforcement. Additionally, gamification and learning analytics are broad examples of pedagogical approaches that fit within behaviourism.

Examples of SoTL educational technology questions based on a behaviourist view of teaching and learning include:

- Do students spend more time in discussions, as seen in learning analytics, after asynchronous video discussions are added to the curriculum?
- How do note-taking strategies differ when students take notes by hand versus on a tablet with a stylus?
- Do students change their behaviour after using virtual reality to practice interview skills? Why or why not?
- How does electronic note-taking impact student studying behaviour?

Cognitivism

Cognitivism is another widely used category of educational theory. This theory focuses on the internal thought process of learners and encourages mental strategies for learning including "perception, executive processes, working memory, encoding, and long-term memory" (Michela, 2018, para. 4). What all the mental strategies have in common is the emphasis on transferring information to students. Within cognitivism, stored knowledge is key to learning. Educators who use cognitivism to frame their instruction may be concerned with how technology can either benefit or hinder the mental focus required for learning or how technology creates an external storage for knowledge and may inhibit use of human memory. Some educators may see technology as a distraction and therefore something to be avoided. Other educators may see technology as a tool that can aid students with learning when the technology is built to support engagement such as using a quiz tool for retrieval practice.

Examples of SoTL educational technology questions based in a cognitivist view of teaching and learning are:

- How does electronic note taking impact students' readiness for a pop quiz?
- Does an in-class electronic quizzing game benefit memorization?
- Do students find the use of color on presentation slides distracting?
- How do students visualize three-dimensional structures from the two-dimensional representations in their textbook?
- Do students retain more information when reading an electronic book versus a print book?

Constructivism

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Humanism

Humanism is a fourth category of learning theory that takes the whole person into account, including their values. Instead of focusing solely on the person's thinking abilities (Miller-Young & Yeo, 2015), Maslow (1970) and others emphasized that learners can be trusted and that it is important to meet students' needs so they may reach their full potential. Educators who align with humanism tend to value student choice, connection, safety, and a positive learning environment.

Examples of SoTL educational technology questions based on a humanist view of teaching and learning are:

- How do students feel when they engage in a full-class quiz review game with a visible leaderboard?
- Are students comfortable when asked to record a video response to questions posed in an online class?
- What would make students more comfortable recording themselves for asynchronous video discussions?
- How do students build relationships with their classmates in an online class?

Social Learning

Social Learning Theory, developed by Albert Bandura (1977), also has specific implications for the use of technology in learning environments. Bandura emphasized that individuals learn through observing, modeling, and imitating others. "…most human behavior is learned observationally through modeling: from observing others one forms an idea of how new behaviors are performed, and on later occasions this coded information serves as a guide for action" (Bandura, 1977, p. 22). Examples include showing a video of famous speeches so students can identify patterns of great orators, looking at images posted on social media to identify fashion trends, and reading a book with characters that cause students to reflect on their own actions.

Examples of SoTL educational technology questions based in a social learning view of teaching and learning are:

- Do students see themselves in the digital material used in class?
- How do the people represented in digital course materials impact students' willingness to engage with the content?
- How do students learn to interact with their peers in online discussions?
- How does interaction through the learning management system change students' perceptions of course content?

Experiential Learning

Another widely used learning theory is experiential learning, which falls within the category of constructivism. Kolb (1984) emphasized that individuals learn best through experience. Kolb identified a four-stage cycle of learning:

- **Concrete experience:** where the learner experiences something,
- **Reflective observation:** where the learner steps back and reflects on the experience,
- **Abstract conceptualization:** where the learner works to understand the experience, and
- **Active experimentation:** where the learner participates in the learning again using their new knowledge.

Examples of SoTL educational technology questions based in an experiential view of teaching and learning are:

- What experiences are students having in the learning management system?
- What challenges do students face in transferring skills from a virtual dissection to an in-person lab?
- In what ways do reflections on virtual experiences differ from reflections on in-person experiences?
- How is abstract conceptualization impacted by virtual learning experiences?

In addition to general educational theories, there are educational theories that are specific to the use of technology for teaching and learning. These include connectivism, mobile learning (m-learning), and social mobile learning (Koole, 2009; McCollum, 2016).

Educational Technology Theories

In this section, two educational technology theories are presented as examples. Many more could be included, and we hope you explore additional theories to find what works best for your SoTL work. Additionally, it is necessary to recognize that theories build on one another and are interconnected. Connectivism and m-learning build on earlier theoretical work.

Connectivism

"Connectivism presents a model of learning that acknowledges the tectonic shifts in society, where learning is no longer an internal, individualistic activity. How people work and function is altered when new tools are utilized" (Siemens, 2005, p. 9). In other words, the internet and the networks and connections it makes cause learning to be dependent on an individual's ability to navigate the network and connections (i.e., the internet).

Examples of SoTL educational technology questions based on a connectivist view of teaching and learning are:

- What connections are students making with course material when they conduct research online?
- How do students find content online?
- What impact does a student's previous experience conducting online research have on their participation in class discussions?
- What materials do students bring into class discussions? Where are they locating these materials?

Mobile Learning (m-Learning)

Mobile learning, or m-learning, is the idea that students use their own personal mobile devices for engagement with others and content during the learning process (Crompton, 2013). More specifically, m-learning is "learning across multiple contexts, through social and content interactions, using personal electronic devices" (Crompton, 2013, p. 4). M-learning emphasizes convenience and the ability of students to work anywhere and anytime while staying socially connected with peers and content.

Examples of SoTL educational technology questions based on an m-learning view of teaching and learning are:

- How frequently do students interact with their classmates?
- Does the frequency of interaction between students impact feelings of connection in the course?
- Where do students typically study?
- How is the location where students study impacting how they interpret the course material?
- What are the effects of screen size and resolution on learning visual material like anatomy diagrams? What do students do to overcome challenges?

These examples are provided to show how our understanding of learning theory can affect the kinds of questions we choose to investigate in considering the value of technology for teaching and learning. Theory is not always explicitly used in SoTL; some chapters in this book are explicit about their use of theory, and some are not. Ultimately, theories serve as tools to think about what is happening during the teaching and learning process, and can strengthen SoTL work by informing the literature review as well as the design of a study. Different theories can illuminate learning in different ways.

Conclusion

While the focus of this chapter is on educational theories, theoretical frameworks are not limited to ideas developed in education. In **Chapter 5**, Alice Watanabe gives an example of how theoretical work by a political thinker (Hannah Arendt) can form the foundation for a SoTL study focused on educational technology. This chapter stands alone as an example of how theory undergirds SoTL educational technology research. During the planning of this book, we (the editors) wanted to include a section on theory because of our belief that theory is essential to grounding a study. However, during our review of the literature, it became clear that there is a gap in the explicit use of theory to inform methodological design. **Chapter 2** expands on the use of theory and asks readers to consider how best to communicate the selection of methodology (grounded in theory) and teaching choices.

Other chapters in the book use theory in various ways. In **Chapter 8**, Brett McCollum used phenomenography as a theoretical framework for designing a SoTL study. Phenomenography is a qualitative research framework, but McCollum explains how it can be used as a grounding theory as well. **Chapter 9** explicitly discusses posthuman theory and actor-network theory and connects these theories to the study design. In **Chapter 12**, Riley J. Petillion and W. Stephen McNeil used social agency theory to inform their approach to video creation. SoTL studies were later conducted on the videos.

We hope the various ways this book captures the use of theory inspire you to consider the theoretical perspective you are bringing to your work and how you use theory to inform your SoTL work.

References

Bandura, A. (1977). *Social learning theory*. General Learning Press.

Brau, B., Fox, N., & Robinson, E. (2018). Behaviorism. In R. Kimmons & S. Caskurlu (Eds.), *The students' guide to learning design and research*. EdTech Books. https://edtechbooks.org/studentguide/behaviorism

Crompton, H. (2013). A historical overview of mobile learning: Toward learner-centered education. In Z. L. Berge & L. Y. Muilenburg (Eds.), *Handbook of mobile learning* (pp. 3–14). Routledge.

Elliott, S. N., Kratochwill, T. R., Littlefield Cook, J., & Travers, J. (2000). *Educational psychology: Effective teaching, effective learning* (3rd ed.). McGraw-Hill College.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Prentice Hall.

Koole, M. L. (2009). A model for framing mobile learning. In M. Ally (Ed.), *Mobile learning: Transforming the delivery of education and training* (pp. 25–47). AU Press.

Maslow, A. H. (1970). *Motivation and personality* (2nd ed.). Harper & Row.

McCollum, B. (2016). Situated science learning for higher level learning with mobile devices. In D. Kennepohl (Ed.), *Teaching science online: Practical guidance for effective instruction and lab work*. Stylus Publishing. https://sty.presswarehouse.com/books/BookDetail.aspx?productID=393126

Michela, E. (2018). Cognitivism. In R. Kimmons & S. Caskurlu (Eds.), *The students' guide to learning design and research*. EdTech Books. https://edtechbooks.org/studentguide/cognitivism

Miller-Young, J., & Yeo, M. (2015). Conceptualizing and communicating SoTL: A framework for the field. *Teaching and Learning Inquiry*, 3(2), 37–53. https://doi.org/10.20343/teachlearninqu.3.2.37

Siemens, G. (2005). Connectivism: A theory for the digital age. *International Journal of Instructional Technology and Distance Learning*, 2(1), 1–9. www.itdl.org/Journal/Jan_05/Jan_05.pdf

4. Communicating our SoTL to Support Scholarly Teaching

BRETT MCCOLLUM

Introduction

Why do SoTL scholars engage in the scholarship of teaching and learning? It can be to better understand our students and their experiences, or to explore the motivations and impacts of our practices. If SoTL is ultimately driven by a desire to improve student learning, then dissemination of our findings in appropriately public venues is a key component of good SoTL practice (Felten, 2013). Effective communication of scholarly inquiry into teaching and learning supports the practices of others – both their own scholarly inquiry and their teaching.

Scholarly Teaching with Educational Technology

Scholarly teaching has been described through an overlapping magisterial model (Potter & Kustra, 2011). The process of scholarly teaching can be described as involving six steps, as shown in **Figure 4.1**. Scholarly teachers ground their practice in conceptually coherent, rational theory. They engage with relevant literature on teaching and learning, including SoTL and discipline-based educational research. Curricular, pedagogical, and assessment choices in scholarly teaching practice are then made based on theory with explicit connections to the literature. Teaching resources are created, curated, or refined with intentionality in alignment with the literature and founding theory. Scholarly teachers then experiment, implementing their resources and trialing their design choices within the wild (a.k.a. the classroom). Ethically appropriate methods are used to collect and evaluate evidence on the efficacy of curricular, pedagogical, and assessment choices. This evaluative process is conducted with a scholarly approach, including identifying your biases and basing your evaluation on evidence not anecdote. Scholarly teachers then critically reflect on the cohesion of the theory, literature, choices, and resources. They critically reflect on the appropriateness of their design for the course, its content, and its audience. They critically reflect on which of their professional skills they can improve to enhance the teaching and learning experience. Finally, the scholarly teacher begins the cycle again, using their critical reflections to guide their use of theory and literature. As educators continue to circumnavigate the scholarly teaching cycle, these research-informed choices shape their teaching identity, which is internally coherent in terms of beliefs, values, and behaviours.

Scholarly teaching with educational technology involves the same steps. Educators seeking to use educational technology in a scholarly teaching manner must familiarize themselves with conceptually coherent, rational theory such as m-Learning and social m-Learning (Koole, 2009; McCollum, 2016). They draw upon the literature to benefit from the knowledge and the experience of others. They make intentional curricular, pedagogical, and assessment choices that are informed by theory and literature. These choices include technological choices, and prompt important course design questions such as:

- What technology will be used, and why?
- Who will use the technology?
- When will the technology be used and for what purpose?

- How does the technology improve the teaching and/or learning experience, such as making the curriculum more accessible, enhancing the pedagogy, or improving the assessment process?
- What are the costs/impacts of including the technology in the course?
- What are the costs/impacts of not including the technology in the course?
- How will the technology alleviate issues of equity?
- How might the technology create new equity-barriers, and how will those be addressed?
- How might the technology impact the cognitive load of learners?
- Can the same learning objectives or student achievement be achieved without the technology?
- How will you evaluate the efficacy of your technological choices?

Scholarly teachers using educational technology then deploy the technology, collect and evaluate evidence on its efficacy, and engage in critically reflective practice to move from personal anecdote to evidence-informed practice (Cooper & Stowe, 2018).

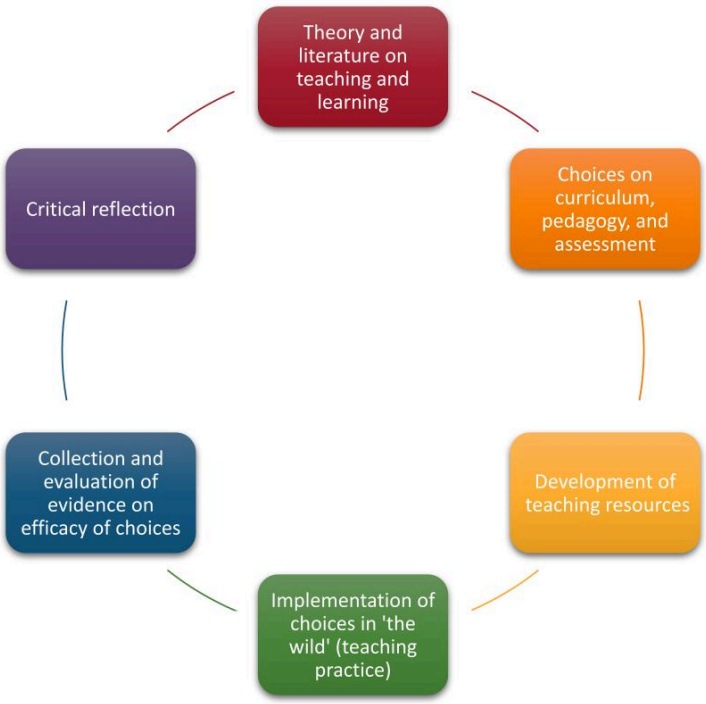

Figure 4.1 *A cyclic process illustrating the steps involved in scholarly teaching. [Long Description available]*

Producing SoTL on Effective Uses of Educational Technology

While scholarly teaching does not require public dissemination, it does involve intentionality informed by established scholarship. As an academic field, the scholarship of teaching and learning creates and shares knowledge that advances our shared objective to improve learning experiences and environments. This often addresses issues of teaching or learning within disciplinary contexts, albeit with an effort to communicate value both within and beyond those disciplinary contexts (Weimer, 2008). In contrast, research questions that strongly emphasize disciplinary content and pose little value outside the disciplinary context are better classified as discipline-based educational research.

Trigwell suggests that "for the SoTL movement to be taken seriously, there needs to be a scholarly evidence-

based practice associated with [its] purposes" (2013, p.96). Academic recognition for the field goes beyond valuing SoTL within tenure and promotion proceedings, as important as those are. It also impacts the willingness of others to read or listen to your findings, and to implement your scholarship within their own practice. For others to successfully use your SoTL findings, it is vital that your dissemination efforts be appropriately scholarly (Glassick et al., 1997), meaning that they should demonstrate:

- clear goals
- adequate preparation
- appropriate methods
- significant results
- effective presentation
- reflective critique

However, there is an important distinction between the aims of the scholarship of teaching and learning and those of most other academic fields. Unlike many esoteric areas of research that rarely have direct or immediate impacts on individuals outside of the field, the scholarship of teaching and learning often aims to directly support the scholarly teaching practice of our broad community of educators in post-secondary environments. These users of SoTL—educators within post-secondary institutions—are experts within their own academic fields. They are skilled evaluators of rigour and reliability in research within their areas of expertise. Yet, without adequate familiarity with the terminology, methodological approaches, theoretical assumptions, and scholarly foundation of a teaching and learning study, a reader may not attain the intellectual and emotional connection necessary to understand the work, appreciate its significance, or feel motivated to instigate change in their practice.

When disseminating SoTL on educational technology, your audience will be particularly interested in your technological choices and how the technology fits within your design. I refer the reader to the course design questions listed earlier in this chapter. Furthermore, your audience will be interested in the evidence of efficacy relative to the stated objectives of the inquiry, as well as your critical reflections on the alignment of the technology with your curriculum, pedagogy, and/or assessments. Clearly communicating your context will assist your audience in assessing what adaptations may be required for their own contexts. For example, a technological learning resource implemented within a small course section of affluent learners may not be feasible at another institution with large course sections and learners from varied socioeconomic backgrounds. Providing a generous set of supporting literature, woven together through a narrative of your scholarly approach to the problem of interest, can be an effective invitation for the audience to join you on your SoTL journey.

It's Not Just About the Technology

While these considerations are important when disseminating all SoTL research we wanted to highlight them in relation to educational technology. When conducting a SoTL study that involves educational technology, it is important to align all aspects of the research to maintain a focus on teaching and learning. The technology fits within that context; in a SoTL project, it should not overshadow the 'T&L' of SoTL. This is not to say that there is no place for research that primarily emphasizes educational technology. Rather, such research is generally a poor fit for a SoTL journal.

In **Section 3** of this book, readers will find examples of scholarly inquiry into the use of educational technology in teaching and learning within post-secondary contexts. Contributors make efforts to identify their choice of research paradigm, theoretical lens, and methodological approaches, and to justify the appropriateness of their choices. They explore the implications of their study for their own practice, and by extension, support the reader in considering potential benefits and consequences of adopting similar practices.

As you read the chapters in **Section 3**, we encourage you to reflect on the position of educational technology within each narrative. The scholarship of teaching and learning is inquiry into teaching and or learning. The technology is part of the context of the study. It may facilitate, support, extend, or enrich teaching or learning. However, the technology is not the purpose or focus of the study; that remains the participants in the teaching and learning experience. This emphasis is particularly important in the context of the rapid technological advancement our world continues to experience. The specific features of an educational technology may change even before a study is published, but the knowledge gained about teaching and learning is expected to have greater longevity.

We hope that, in your reading, you observe your attention being directed not to the specific technology choices of the researchers, but to the intentional design and implementation of their inquiry. Additionally, it is our hope that this book serves as an exemplar of how SoTL scholars should be explicit about their study's design and assumptions, including epistemology, ontology, axiology, theoretical framework, and the motivation, development, and choice of their research questions. Being explicit in our writing supports practitioners and new SoTL scholars. It also helps us stay focused on our goal of improving student learning.

Disseminating SoTL to Scholars and Practitioners

In some ways, dissemination of the scholarship of teaching and learning has similarities to journalism. Adapting the work of Nelkin (1995) to SoTL dissemination, the role of publishing and presenting on SoTL for non-specialist audiences is to:

- Keep educators apprised of advancements in teaching and learning, often from positivist or humanist perspectives.
- Explain the appropriateness of a theoretical lens and methodological approaches for the study.
- Explicitly address the implications of the study for reflective and evidence-based teaching practices.
- Inform educators about choices relative to risks for themselves and their learners.

Keep in mind that there is potential risk to learners from stagnant pedagogy as much as from ineffective innovative practices.

Certainly, SoTL has additional roles in advancing the intellectual work of others in the field. The presence of numerous academic journals devoted to teaching and learning in and across the disciplines is evidence of this work. Yet, for scholars of teaching and learning to effectively support their disciplinary-research peers in improving teaching practices, we must keep the above roles of SoTL dissemination foremost in our minds during our dissemination activities.

The Scholarship of Abysmal Failures

Academics are well-aware that research often has unexpected twists and turns. Brave, enthusiastic, and adventurous educators pushing the boundaries of what has been done with educational technology have personal stories of abysmal failures. When studying the use of educational technology as a SoTL scholar, we should keep in mind that 'negative' results are still valuable. Dissemination of what you attempted, why, and how—with explicit references to design choices and underlying assumptions—and effective communication of what happened can fulfill a key role in the scholarship of teaching and learning, particularly in relation to the practices of non-specialists. Namely, it can inform

educators about the consequences of particular choices, helping them avoid unnecessary risk for themselves and their learners should they choose to explore similar teaching and learning strategies involving educational technology.

Asking and Posing Questions

I pose the following series of questions for the reader to consider as they engage with this book. We, the editors of this book, also encourage you to use these questions as you develop your own SoTL studies related to educational technology:

- What aspect of teaching and/or learning is the investigator seeking to affect with educational technology?
- With which genre of SoTL does the study best align? (Example: Inquiry)
- What paradigm, philosophical belief, theoretical approach, and associated assumptions is the investigator using in their study?
- How do these design choices influence the findings and/or interpretations of the study?
- Are non-SoTL experts in higher education among the author's intended audience? If so, how does the author communicate their study to support the scholarly teaching of this audience?
- Which findings are intended to support adoption of similar practices, and which are presented as advice to avoid unnecessary risk?

You may also wish to reflect on the following questions as you read:

- How do you currently determine if a particular approach to using educational technology leads to effective learning?
- Are your methods or metrics for analyzing the use and impact of educational technology appropriate, and do they include inclusive and equitable lenses?
- Does your inquiry into educational technology tend to focus on cost, benefit, barrier, or opportunity in teaching and learning?
- How can you more effectively communicate your scholarship on teaching and learning to support both scholars and practitioners?

Finally, we challenge you to reframe each of the following research questions to shift their focus away from the educational technology itself and instead toward the related teaching and/or learning goals.

Table 4.1 ***Reframing Research Questions***

Research Questions Focused on Educational Technology	**SoTL Research Questions Focused on a Context Involving Educational Technology**
Which design features are available in social media platforms for professional development?	
What analytics are available in different learning management systems?	
What interactive features can be embedded within online instructional videos?	
In a course gamification app, how does the artificial intelligence make decisions to replicate a real player?	
How can statistical syntax and introductory concepts be represented in R, SPSS, and MATLAB?	

References

Cooper, M. M., & Stowe, R. L. (2018). Chemistry education research—From personal empiricism to evidence, theory, and informed practice. *Chemical Reviews*, *118*(12), 6053–6087. https://doi.org/10.1021/acs.chemrev.8b00020

Felten, P. (2013). Principles of good practice in SoTL. *Teaching and Learning Inquiry*, *1*(1), 121–125. https://doi.org/10.2979/teachlearninqu.1.1.121

Koole, M. L. (2009). A model for framing mobile learning. In M. Ally (Ed.), *Mobile learning: Transforming the delivery of education and training* (pp. 25–47). Athabasca University Press.

McCollum, B. (2016). Situated science learning for higher level learning with mobile devices. In Kennepohl, D. (Ed.), *Teaching science online: Practical guidance for effective instruction and lab work*. Stylus Publishing. https://sty.presswarehouse.com/books/BookDetail.aspx?productID=393126

Nelkin, D. (1995). *Selling science: How the press covers science and technology*. W. H. Freeman.

Potter, M. K., & Kustra, E. (2011). The relationship between scholarly teaching and SoTL: Models, distinctions, and clarifications. *International Journal for the Scholarship of Teaching and Learning*, *5*(1), Article 23. https://doi.org/10.20429/ijsotl.2011.050123

Trigwell, K. (2013). Evidence of the impact of scholarship of teaching and learning purposes. *Teaching and Learning Inquiry*, *1*(1), 95–105. https://doi.org/10.20343/teachlearninqu.1.1.95

Weimer, M. (2008). Positioning scholarly work on teaching and learning. *International Journal for the Scholarship of Teaching and Learning*, *2*(1), Article 4. https://doi.org/10.20429/ijsotl.2008.020104

Media Attributions

All images in this chapter have been created by the author, unless otherwise noted below.

Long Descriptions

Figure 4.1 Long Description: A circular diagram showing the cyclic process of the Scholarship of Teaching and Learning (SoTL) with six connected steps: [clockwise from top]

1. Theory and literature on teaching and learning
2. Choices on curriculum, pedagogy, and assessment
3. Development of teaching resources
4. Implementation in practice
5. Collection and evaluation of evidence
6. Critical reflection, which loops back to the first step

[Return to Figure 4.1]

5. Plurality, Promise, and Forgiveness as Philosophical Foundations for SoTL Projects in Educational Technology Contexts

ALICE WATANABE

Introduction

New technologies, such as artificial intelligence (AI) or learning analytics, are considered current educational trends worldwide, which will strongly shape learning and teaching in higher education (Tuomi, 2018; Gimpel et al., 2023; Ocaña-Fernández et al., 2019). Many education scholars hope that the use of new educational technologies will enable students to study more efficiently, successfully, and quickly, reducing both the cost of a degree and the amount of time spent studying (Nuxoll, 2023; Schumacher & Ifenthaler, 2021; UNESCO International Institute for Higher Education in Latin America and the Caribbean, 2023). Technology-enhanced teaching and learning currently focuses on the use of generative AI (especially ChatGPT) (Farrokhnia et al., 2024 ; Gimpel et al., 2023; Michel-Villarreal et al., 2023) and adaptive learning environments or intelligent tutoring systems (Crompton & Burke, 2023; Wang et al., 2023; Zawacki-Richter et al., 2019), which are mainly explored in educational science on the basis of empirical studies and conceptual guidelines (von Garrel et al., 2023; Preiß et al., 2023; Gimpel et al., 2023).

In addition, educational researchers are looking more generally at the use of new educational technologies and considering critical issues. For example, Castañeda and Selwyn (2018) question whether technology- enhanced learning can increase students' focus on their own academic success, reducing interaction with other students or collaborative learning. Furthermore, the educationalist Macgilchrist (2019) sees a danger in the use of technology where learners will increasingly subject their studies to an end-use category, while Watanabe (2023) discusses the ways in which AI in higher education shows totalitarian tendencies. Basically, various educational scientists appeal for a critical, interdisciplinary discussion and refer to the complexity within educational sciences, which cannot be understood only through data-supported, new technologies (Humble & Mozelius, 2019; Selwyn et al., 2020; Watanabe, 2023).

In this context, there is also a growing request for theoretical approaches to technology-enhanced learning (Ocaña-Fernández et al., 2019; Ifenthaler, 2023; Reinmann & Watanabe, 2024). However, it proves difficult to relate abstract philosophical considerations to precise educational science concepts or technology-supported teaching.

The chapter addresses this research desideratum by reframing the central concepts—plurality, promise, and forgiveness—of the political thinker Hannah Arendt (Arendt, 1998) and placing them within a theoretical investigation in the context of SoTL and technology-enhanced teaching. On the one hand, SoTL is particularly suitable for this investigation as it is characterized by a clear educational science concept and an open format that allows SoTL to be extended to include philosophical considerations (Huber, 2014). On the other hand, SoTL provides educators with a framework for exploring very different areas of technology-supported teaching and learning in a structured way (Watanabe, 2022). In this regard, SoTL is used to connect Arendt's reflections with educational science demands on technology-enhanced teaching and learning. Simultaneously, this way of proceeding also adds a theoretical perspective to SoTL and helps to think about possible extensions. The aim is to provide educational scientists and SoTL actors with theoretical references and to illuminate both SoTL and the use of new educational technologies from a philosophical perspective. Therefore, the focus circles around the question of how Arendt's central concepts correspond to SoTL and

how they can act as extensions of SoTL. Additionally, the added value combining Arendt's philosophical thoughts and SoTL for technology-enhanced learning and teaching will be discussed.

Scholarship of Teaching and Learning: Foundations and Current Trends

The core of SoTL is the systematic examination and reflection of one's own teaching and the publication of the results, which enable discussion and lead to an academic exchange of teaching experiences (Huber, 2014). A current trend in SoTL is the exploration of technology-enhanced formats, such as online teaching, flipped classroom approaches, and gamification (Mårtensson & Schrum, 2022). In addition to these research interests, Vöing et al. (2022) identify four emerging trends:

1. Active involvement of students in teaching research
2. Review of subject-related teaching-learning scenarios in higher education
3. Promotion of a subject- and teaching-related transfer of experience and knowledge
4. Transfer of experience and knowledge across university types and status groups

The following analysis shows how Arendt's reflections provide a theoretical basis for Points 1, 3, and 4. Point 2 will not be taken up, since specific considerations of teaching-learning scenarios are more likely to be discussed in different disciplinary contexts and cannot be addressed by general approaches to philosophical education.

Plurality, Promise and Forgiveness

Hannah Arendt's work is related to political theory and has fascinated humanity scholars, social scientists, and the public for years (Thaa, 2008). Her literature is essayistic and unconventional. However, despite numerous criticisms, such as her utopian understanding of the political theory (Höffe, 1993), Arendt has managed to inspire a wide audience with her philosophical reflections (Neumann et al., 2001). With her redefinition of the political theory, she has significantly influenced various disciplines in the humanities and is now considered a modern classic (Weißpflug, 2019).[1]

In her book *The Human Condition*, the political thinker explains her understanding of politics, which is based on the ancient Greek polis. According to this, people are politically active when they meet as free and equal beings and begin to speak and act together in the world. Central to Arendt's understanding of politics are human plurality, making and keeping promises to one another, and forgiving each other (Arendt, 1998, 2005). In the following section, these terms will be examined in more detail and then placed in context to SoTL.[2]

1. A special characteristic of Arendt's work is the high impact outside of her own discipline. For example, there is a growing interest in educational sciences to use Arendt's philosophical reflections to elaborate philosophical theories and concepts of education (Jahn, 2017; Nixon, 2020, Watanabe, 2023). A more detailed discussion of this aspect will be presented in the next section.
2. Arendt's reflections are summarized very briefly. For a more in-depth reading, readers are recommended to consult the book The Human Condition (Arendt, 1998).

Plurality

According to Arendt, human plurality arises from the fact that people are, on the one hand, alike and, on the other hand, different. The characteristic of similarity is seen by Arendt as a basic prerequisite and already exists in the fact that people acting together are all living persons. Much more interesting for Arendt is the characteristic of difference. By this feature, the theorist understands that each person sees and evaluates the world from a particular perspective, which gives origin to different points of view. She describes this consideration by comparing the world to a table, around which different people are gathered. Each of the assembled people view the table from a specific perspective unique from the other ones, giving birth to different points of view. In their summation, the singular, different positions of the people result in human plurality (Arendt, 1998):

> If someone wants to see and experience the world as it 'really' is, he can do so only by understanding it as something that is shared by many people, lies between them, separates and links them, showing itself differently to each and comprehensible only to the extent that many people talk about it and exchange their opinions and perspectives with one another, over against one another. (Arendt, 2005, p. 128).

Promises and Forgiveness

According to Arendt, people need mutual trust and must keep their promises when they share their points of view with each other or start a new project together. The factors trust and promise are especially essential because not everything can be planned in joint action and mistakes can occur. Arendt describes joint action as a web into which people spin new strings together in the form of new ideas and actions. In this process, the participants do not know what the pattern will look like in the end, which often leads to errors and uncertainties. According to Arendt, these must be endured by the actors. Also, the acting people have to trust that everyone involved will act in good conscience and keep their promises (Arendt, 1998).

Because of the unpredictable course of a common action and the fact that the results of the process of action cannot be undone, it is equally important for the actors to forgive mistakes or misjudgements. The following passage illustrates how central Arendt considers the activity of forgiveness for common action:

> Without being forgiven, released from the consequences of what we have done, our capacity to act would, as it were, be confined to one single deed from which we could never recover; we would remain the victims of its consequences forever (Arendt, 1998, p. 273).

Plurality, Promise, and Forgiveness as Philosophical Foundations for SoTL Projects in Educational Technology Contexts

After explaining central concepts of Arendt's political theory, these will now be connected to SoTL and placed in a context for technology-enhanced learning. In general, Arendt's reflections on political theory receive much attention in the field of higher education. In his 2020 published book *Hannah Arendt. The Promise of Education*, Jon Nixon places a wide variety of Arendt's concepts and reflections in an educational context and describes the political thinker as a public educator (Nixon, 2020). Also, Arendt's theories of action and thinking are already being used to theoretically frame educational science concepts or methodologies, such as the design-based-research approach (Jahn, 2017) or the activity of critical thinking in universities (Watanabe & Schmohl, 2021).

Educationalists' enthusiasm for Arendt may be related to the fact that, unlike most philosophers, the theorist Arendt does not present a unified system of thought in her texts and does not identify herself with any particular philosophical school (Grunenberg, 2003). This openness enables other disciplines to take up certain concepts or considerations of Arendt and to place them in a different (in this case, educational science) context.

Arendt's reflections, however, make a suitable theoretical foundation for SoTL projects in the context of educational technology for two further substantive reasons. Firstly, Arendt places human plurality at the centre of her philosophical considerations (Ludz, 1993) and is, thus, highly compatible with the diversity of SoTL projects. Secondly, Arendt is intensely engaged with the question of how people can act together and realize joint projects. Especially regarding SoTL projects, which are fundamentally about exploring and discussing actions in teaching-learning contexts with others, Arendt's theories enable us to grasp and think further about SoTL. Whether Arendt's political concepts of plurality, trust, and forgiveness are applicable to SoTL and technology-enhanced teaching and learning is discussed below.

Plurality in SoTL and the Context of New Educational Technology Contexts

Essentially, SoTL describes educators who research their own teaching, publish their findings in a follow-up, and share them with the professional community (Huber, 2014). SoTL, thus, combines teaching and research and has the overarching goal of improving quality and evidence-based teaching practices within higher education (Boyer, 1990). In this regard, SoTL is characterized primarily by its openness, which is visible, for example, in the interdisciplinary character of SoTL (Miller-Young & Yeo, 2015) or in the various publication formats (Schmohl, 2019). Arendt's philosophical considerations on plurality can be easily applied to SoTL. Accordingly, to SoTL, the table described by Arendt would not be the world but would instead represent academic teaching. The people gathered around the table are SoTL actors who use their specific teaching experiences to generate universally relevant insights and discuss their points of view with other scholars. Above all, publication and discussion with other SoTL actors (Davies, 1999; Shulman , 1998) can be understood as a form of Arendt's concept of plurality.

Regarding the use of new technologies in higher education context, educational scholars express their desire for an interdisciplinary exchange in which new technologies are considered from different perspectives. Selwyn et al. (2020, p. 5) summarize this demand pointedly:

> Indeed, some of the most interesting new ideas that can drive these reimaginings of digital education can be found in interdisciplinary areas still forming in between the computational and social sciences – i.e. critical data studies, anticipatory studies, critical design. It is crucial that critical EdTech scholars continue to pay close attention to such hybrid areas of debate and inquiry.

This statement highlights how well Arendt's reflections on plurality line up with SoTL and the exploration of new technologies in education.

However, Arendt's theoretical analysis goes one step further. In her theory of action, the political thinker not only addresses the common exchange and representation of different perspectives, she also pleads for people to act together (Arendt, 1998). For SoTL, this consideration would mean that educators from different disciplines team up and teach together with or about new educational technologies and research their own theories and methods based on their own teaching subsequently. Two examples briefly outline what such SoTL projects might look like:

Example #1 Teaching *about* new technologies:

Educators from the fields of philosophy, sociology, and computer science join forces and give a

collaborative seminar on AI-supported chatbots and then analyse their teaching methods together. While in computer science, the technical basics would be given (adapted to the level of the respective students), in humanities or social sciences, a discussion about societal implications and ethical problems would take place. After the seminar, the educators can evaluate the course mutually, work out strengths and weaknesses, and publish their results in the SoTL community. Through this interdisciplinary teaching-learning setting, both teachers and students learn about new technologies from different perspectives and implement an interdisciplinary approach.

Example #2 Teaching *with* new technologies:

Teachers from various disciplines use an intelligent tutor system or ChatGPT in their courses to support students' personalised learning with the help of AI applications. After the course, the teachers examine the use of the intelligent tutor system or ChatGPT and discuss their findings and problems with the other educators. On this basis, the SoTL scholars can derive and publish subject-specific and generally valid findings. Through this approach, differences and similarities between the disciplines in relation to technology-enhanced teaching and learning can be identified.

With the help of Arendt's considerations on plurality, it is also possible to think about whether students should play a more active role in SoTL projects. For example, it might be conceivable to expand evaluations further and interview selected students about the educational implementation of seminars. In addition, teachers could first discuss their SoTL findings from the course with the students and, thus, check whether the learners agree or disagree with them. Through this approach, student participation could be increased and SoTL actors could review their findings about the course more directly. Especially in the field of technology-supported learning, students could participate and shape the future of higher education. Including students also helps counteract the danger of technology-enhanced learning, which causes students to focus only on their individual academic success and have less interest in fellow peers or democratic participation (Castañeda & Selwyn, 2018; Watanabe, 2023).

These examples highlight how Arendt's considerations on plurality provide a theoretical basis for the transfer of subject-related knowledge, for transdisciplinary collaboration, and for the inclusion of students in SoTL in relation to the current tendencies of SoTL (Section 1). Thus, Arendt's thoughts on plurality can be profitably applied to SoTL projects in the field of new educational technologies.

However, educational researchers already consider the open, interdisciplinary discourse of SoTL projects to be challenging for many researchers who normally research only under discipline-specific requirements (Huber, 2014). Conducting cross-disciplinary seminars (see example: Teaching about new technologies) or joint evaluation and analysis of educational technologies (see example: Teaching with new technologies) could lead to further tensions and pressures between SoTL actors. A clear division of tasks and the use of checklists and guidelines, such as those already used by educational researchers to ensure an academic standard (Glassick et al., 1997), can be helpful here as well.

In contrast, student involvement in SoTL is less problematic. Due to the openness of SoTL (Reinmann, 2019), the teacher is free to choose the method or level to which they want to share and discuss their findings with students during the course. The only necessary factor is that SoTL actors have knowledge of educational and/or social science methods and conduct them correctly (Schmohl, 2019). In basic terms, however, it can be assumed that courses with a low number of participants are especially suitable for this approach.

Promise and Forgiveness in Sotl and in the Context of New Educational Technologies

While SoTL already embodies pluralistic and interdisciplinary approaches (Huber, 2014), aspects of promise

or forgiveness are not yet addressed in SoTL. This is not surprising, since these primarily philosophical concepts seem, at first, too abstract for precise teaching-learning projects. In principle, these activities also do not seem to be particularly important for SoTL, since the focus is on evidence-based research and the presentation of results within the SoTL community (Boyer, 1990; Huber, 2014). However, forgiveness is a good point of reference for SoTL participants. Particularly because SoTL is about discovering problems, or even errors, within one's own teaching and deriving universal insights from them. Therefore, it is important that teachers admit and forgive themselves for mistakes made in learning-to-learn contexts.

Furthermore, there is a need for an open SoTL community, in which academics can address mistakes or problems within their teaching and rely on the understanding and forgiveness of other SoTL participants. Especially for young teachers, their own and others' forgiveness is elementary to act out their teaching methods and try out new things.

Also, for the extensions of SoTL described above, the activities of promising and forgiving can strengthen collaborative action in SoTL projects. Due to the fact that interdisciplinary teaching and collaboration pulls teachers out of their subject-specific comfort zone (Schmohl, 2019), it is elementary to trust each other, keep promises, and forgive each other's mistakes (Arendt, 1998). Only through this attitude can joint action and the follow-up seminar analysis take place successfully.

Involving students in SoTL projects also requires that they feel safe and have the desire to discuss the teaching format with the lecturer. Since there is a general hierarchy between teachers and students, which is neither compatible with the open nature of SoTL nor Arendt's theory of action (Arendt, 1998; Boyer, 1990), strategies must be found to remove this hierarchy in the discussion about the teaching format. By showing students that they make and keep their promises, teachers build trust and enable students to express themselves openly and critically about the educational design. However, it is equally important that teachers admit mistakes they have made and ask students to forgive them.

In the context of new technologies, promise and forgiveness play an especially important role. Currently, it is not clear what impact new technologies, such as AI and learning analytics, will have on education and what forms and types of technology-enhanced learning are appropriate for higher education (Herzberg, 2023; Ifenthaler, 2023). Here, educational science embarks on a journey of discovery (Sesink, 1990) and can only find out how and which technologies are suitable for teaching-learning situations through trial and error and must endure uncertainty and the unknown (de Witt & Leineweber, 2020).

On the one hand, it is important that educators explore the use of new technologies in teaching-learning contexts based on SoTL and discuss general findings with the professional community (Watanabe, 2022). On the other hand, teachers need to inform students about this situation, make clear promises about technology-supported teaching and learning, keep those promises , take responsibility for mistakes, and ask students to forgive them. Learners and teachers are directly affected when using new technologies (Gimpel et al., 2023; Reinmann & Watanabe, 2024). Together, they need to explore how new technologies can be wisely and appropriately integrated into teaching-learning contexts.

For this, Arendt's reflections on forgiveness and promises, as well as the SoTL extension described above, provide first orientation points that can be used to support subject-based knowledge transfer, enabling transdisciplinary collaboration and engaging students.

In this context, it should be pointed out that forgiveness and promise need to be anchored primarily within the attitude of SoTL actors while also including it in their teaching. At this point, the individual responsibility and challenges involved in transferring abstract philosophical approaches to concrete teaching-learning settings show up. Despite this difficulty, it seems to be elementary that professors adopt this inner attitude for university teaching, especially regarding the use of new educational technologies and its associated uncertainty.

Conclusion

In this chapter, Hannah Arendt's reflections on the term s "plurality," "promise," and "forgiveness" were placed in a context of SoTL and technology- enhanced teaching and learning. On the one hand, Arendt's philosophical reflections helped to theoretically underpin SoTL. Thus, Arendt's philosophy provides a good theoretical basis to address the openness and interdisciplinarity of SoTL. On the other hand, possible extensions of SoTL in technology-supported teaching and learning were discussed. Thereby, three central extension possibilities for SoTL were identified:

- Teachers from different disciplines team up, such as by giving a joint seminar about a new technology, investigating their teaching format together, and then publishing their findings.
- Teachers from different disciplines use the same educational technology and subsequently compare their results with each other. This allows both discipline specific and general findings to be captured and published.
- Teachers involve their students in SoTL by sharing and discussing their research on their own teaching with students.

These extensions were each put in a context of technology-enhanced teaching and learning. In addition, the chapter discussed the extent to which promising and forgiving can be a philosophical basis for SoTL expansion and why these activities are important for the use of new educational technologies. Together, Arendt's philosophical considerations and SoTL provide a framework for grounding new technologies with theoretical reference and in a teaching design.

Although SoTL was named in the 1990s (Boyer, 1990), it has not yet lost its relevance (McEwan, 2022). Interest in SoTL continues to grow, underscoring its importance in educational science. And precisely because SoTL has proven so successful, it is important to think further about the concept and expand it with new perspectives.

How suitable the presented extensions and philosophical aspects are for SoTL actors can only be seen in their application. They are philosophical proposals that offer SoTL actors alternative perspectives to explore the use of new technologies in their own teaching-learning contexts.

Reflective Questions

In order to integrate Arendt's philosophical approaches into their teaching-learning contexts, teachers and SoTL actors can ask themselves the following questions:

- To what extent does openness and plurality play a role in my teaching and how might I extend this (especially in relation to technology enhanced teaching and learning)?
- How do I live and address a practice of trust and forgiveness in my teaching (especially in relation to the use of new technologies)?
- How can I use philosophical thought to impact my own use of SoTL and technology enhanced teaching?

References

Arendt, H. (1998). *The human condition*. The University of Chicago Press.

Arendt, H. (2005). *The promise of politics*. Schoken Books.

Boyer, E. L. (1990). *Scholarship reconsidered: Priorities of the professoriate. A special report*. The Carnegie Foundation for the Advancement of Teaching.

Castañeda, L., & Selwyn, N. (2018). More than tools? Making sense of the ongoing digitizations of higher education. *International Journal of Educational Technology in Higher Education*, 15, Article 22. https://doi.org/10.1186/s41239-018-0109-y

Crompton, H., & Burke, D. (2023). Artificial intelligence in higher education: The state of the field. *International Journal of Educational Technology in Higher Education*, 20, Article 22. https://doi.org/10.1186/s41239-023-00392-8

Davies, C. A. (1999). *Reflexive ethnography: A guide to researching selves and others*. Routledge.

de Witt, C., & Leineweber, C. (2020). Zur Bedeutung des Nichtwissens und die Suche nach Problemlösungen: Bildungstheoretische Überlegungen zur Künstlichen Intelligenz. *MedienPädagogik: Zeitschrift für Theorie und Praxis der Medienbildung*, 39(Orientierungen), 32–47. https://doi.org/10.21240/mpaed/39/2020.12.03.X

Farrokhnia, M., Banihashem, S. K., Noroozi, O., & Wals, A. (2024). A SWOT analysis of ChatGPT: Implications for educational practice and research. *Innovations in Education and Teaching International*, 61(3), 460–474. https://doi.org/10.1080/14703297.2023.2195846

Gimpel, H., Hall, K., Decker, S., Eymann, T., Lämmermann, L., Mädche, A., Röglinger, M., Ruiner, C., Schoch, M., Schoop, M., Urbach, N., & Vandrik, S. (2023). *Unlocking the power of generative AI models and systems such as GPT-4 and ChatGPT for higher education: A guide for students and lecturers* [White paper]. Universität Hohenheim, Fakultät Wirtschafts- und Sozialwissenschaften. https://doi.org/10.13140/RG.2.2.20710.09287/2

Glassick, C. E., Huber, M. T., & Maeroff, G. I. (1997). *Scholarship assessed: Evaluation of the professoriate. A special report*. Jossey-Bass.

Grunenberg, A. (2003). *Arendt. Herder-Spektrum Meisterdenker: Vol. 4954*. Herder.

Herzberg, D. (2023). Künstliche Intelligenz in der Hochschulbildung und das Transparenzproblem: Eine Analyse und ein Lösungsvorschlag. In T. Schmohl, A. Watanabe, & Kathrin Schelling (Eds.), *Hochschulbildung: Lehre und Forschung: Vol. 4. Künstliche Intelligenz in der Hochschulbildung: Chancen und Grenzen des KI-gestützten Lernens und Lehrens* [transcript] (pp. 87–98).

Höffe, O. (1993). Politische Ethik im Gespräch mit Hannah Arendt. In P. Kemper (Ed.), *Die Zukunft des Politischen. Ausblicke auf Hannah Arendt* (pp. 13-34). Fischer.

Huber, L. (2014). Scholarship of Teaching and Learning. Konzept, Geschichte, Formen, Entwicklungsaufgaben. In L. Huber, A. Pilniok, R. Sethe, B. Szczyrba, & M. P. Vogel (Eds.), *Blickpunkt Hochschuldidaktik. Forschendes Lehren im eigenen Fach: Scholarship of Teaching and Learning in Beispielen* (pp. 19–36). Bertelsmann.

Humble, N., & Mozelius, P. (2019). Artificial intelligence in education – A promise, a threat or a hype. In P. Griffiths & M. N. Kabir (Eds.), *Proceedings of the European Conference on the Impact of Artificial Intelligence and Robotics* (pp. 149–156). Academic Conferences & Publishing.

Ifenthaler, D. (2023). Ethische Perspektiven auf künstliche Intelligenz im Kontext der Hochschule. In T. Schmohl, A. Watanabe, & Kathrin Schelling (Eds.), *Hochschulbildung: Lehre und Forschung: Vol. 4. Künstliche Intelligenz in der Hochschulbildung: Chancen und Grenzen des KI-gestützten Lernens und Lehrens* [transcript] (pp. 71–86).

Jahn, D. (2017). Entwicklungsforschung aus einer handlungstheoretischen Perspektive: Was Design Based Research von Hannah Arendt lernen könnte. EDeR. *Educational Design Research*, 1(2). https://doi.org/10.15460/eder.1.2.1144

Ludz, U. (1993). Kommentar zu Was ist Politik. In H. Arendt, *Was ist Politik? Fragmente aus dem Nachlaß* (pp. 137–190). Piper.

Macgilchrist, F. (2019). Cruel optimism in edtech: When the digital data practices of educational technology providers inadvertently hinder educational equity. *Learning, Media and Technology*, 44(1), 77–86. https://doi.org/10.1080/17439884.2018.1556217

Mårtensson, K., & Schrum, K. (2022). Becoming Teaching & Learning Inquiry: Celebrating our 10th anniversary. *Teaching and Learning Inquiry*, 10. https://doi.org/10.20343/teachlearninqu.10.1

McEwan, M. P. (2022). The journey to SoTL: Institutionally supporting a transition to scholars of teaching and learning. *International Journal for the Scholarship of Teaching and Learning*, 16(2), Article 5. https://eric.ed.gov/?id=ej1344091

Michel-Villarreal, R., Vilalta-Perdomo, E., Salinas-Navarro, D. E., Thierry-Aguilera, R., & Gerardou, F. S. (2023). Challenges and opportunities of generative AI for higher education as explained by ChatGPT. *Education Sciences*, 13(9), Article 856. https://doi.org/10.3390/educsci13090856

Miller-Young, J., & Yeo, M. (2015). Conceptualizing and communicating SoTL: A framework for the field. *Teaching & Learning Inquiry*, 3(2), 37–53. https://doi.org/10.20343/teachlearninqu.3.2.37

Neumann, B., Mahrdt, H., & Frank, M. (Ed.). (2001). *The angel of history is looking back. Hannah Arendts Werk unter politischem, ästhetischem und historischem Aspekt; Texte des Trondheimer Arendt-Symposions vom Herbst 2000*. Königshausen & Neumann.

Nixon, J. (2020). *Hannah Arendt: The promise of education*. Springer.

Nuxoll, F. (2023). *KI in der Schule. Bundeszentrale für politische Bildung*, S. 41–46. https://www.bpb.de/shop/zeitschriften/apuz/kuenstliche-intelligenz-2023/541500/ki-in-der-schule/

Ocaña-Fernández, Y., Valenzuela-Fernández, L. A., & Garro-Aburto, L. L. (2019). Artificial intelligence and its implications in higher education. *Journal of Educational Psychology – Propositos Y Representaciones*, 7(2), 553–568.

Preiß, J., Bartels, M., Niemann-Lenz, J., Pawlowski, J., & Schnapp, K.-U. (2023). *"ChatGPT and me" Erste Ergebnisse der quantitativen Auswertung einer Umfrage über die Lebensrealität mit generativer KI an der Universität Hamburg*. Universität Hamburg. https://doi.org/10.25592/uhhfdm.13403

Reinmann, G. (2019). Die Selbstbezüglichkeit der hochschuldidaktischen Forschung und ihre Folgen für die Möglichkeiten des Erkennens. In T. Jenert, G. Reinmann, & T. Schmohl (Eds.), *Hochschulbildungsforschung: Theoretische, methodologische und methodische Denkanstöße für die Hochschuldidaktik* (pp. 125–148). Springer.

Reinmann, G., & Watanabe, A. (2024). KI in der universitären Lehre: Vom Spannungs- zum Gestaltungsfeld. In G. Schreiber, & L. Ohly (Eds.), *KI: Text: Diskurse über KI-Textgeneratoren* (pp. 29–46). De Gruyter. https://doi.org/10.1515/9783111351490

Schmohl, T. (2019). Wider die Vulgärdidaktik. In T. Schmohl & K.-A. To (Eds.), *TeachingXchange. Hochschullehre als reflektierte Praxis. Fachdidaktische Fallbeispiele mit Transferpotenzial* (pp. 149–169). wbv.

Schumacher, C., & Ifenthaler, D. (2021). Investigating prompts for supporting students' self-regulation: A remaining challenge for learning analytics approaches? *The Internet and Higher Education*, 49, Article 100791. https://doi.org/10.1016/j.iheduc.2020.100791

Selwyn, N., Hillman, T., Eynon, R., Ferreira, G., Knox, J., Macgilchrist, F., & Sancho-Gil, J. M. (2020). What's next for Ed-Tech? Critical hopes and concerns for the 2020s. *Learning, Media and Technology*, 45(1), 1–6. https://doi.org/10.1080/17439884.2020.1694945

Sesink, W. (1990). Künstliche Intelligenz, Systemreproduktion und Bildung. *Neue Sammlung*, 30(2), 193–207.

Shulman, L. S. (1998). Course anatomy: The dissection and analysis of knowledge through teaching. In P. Hutchings (Ed.), *The course portfolio: How faculty can examine their teaching to advance practice and improve student participation* (pp. 5–12). American Association for Higher Education.

Thaa, W. (2008). Repräsentation oder politisches Handeln? Ein möglicherweise falscher Gegensatz im Denken Hannah Arendts. In C. Vollnhals (Ed.), *Vol. 35. Schriften des Hannah-Arendt-Instituts für Totalitarismusforschung* (pp. 71–88).

Tuomi, I. (2018). JRC science for policy report. The impact of artificial intelligence on learning, teaching, and education policies for the future (M. Cabrera, R. Vuorikari, & Y. Punie, Eds.). Publications Office of the European Union. https://doi.org/10.2760/12297

UNESCO International Institute for Higher Education in Latin America and the Caribbean. (2023). *ChatGPT and artificial intelligence in higher education: Quick start guide*. https://unesdoc.unesco.org/ark:/48223/pf0000385146

von Garrel, J., Mayer, J. & Mühlfeld, M. (2023). *Künstliche Intelligenz im Studium: Eine quantitative Befragung von Studierenden zur Nutzung von ChatGPT & Co.*

Vöing, N., Reisas, S., & Arnold, M. (2022). Einleitung. In N. Vöing, S. Reisas, & M. Arnold (Eds.), *Forschung und Innovation in der Hochschulbildung: Scholarship of Teaching and Learning: Eine forschungsgeleitete Fundierung und Weiterentwicklung hochschul(fach)didaktischen Handelns* 16 (pp. 7–17). DUZ.

Wang, H., Tlili, A., Huang, R., Cai, Z., Li, M., Cheng, Z., Yang, D., Li, M., Zhu, X., & Fei, C. (2023). Examining the applications of intelligent tutoring systems in real educational contexts: A systematic literature review from the social experiment perspective. *Education and Information Technologies*, 28 , 9113–9148 . https://doi.org/10.1007/s10639-022-11555-x

Wannemacher, K., & Bodmann, L. (2021). *Künstliche Intelligenz an den Hochschulen: Potenziale und Herausforderungen in Forschung, Studium und Lehre sowie Curriculumentwicklung. Arbeitspapier* Nr. 59. Hochschulforum Digitalisierung.

Watanabe, A. (2022). Let's talk about artificial intelligence: How scholarship of teaching and learning can enhance the AI scientific discourse in higher education . In F. A. Menâendez, A. Maz Machado, C. Lâopez Esteban, & C. A. Lâopez (Eds.), *Strategy, policy, practice, and governance for AI in higher education institutions* (pp. 48–72). IGI Global Scientific Publishing. https://doi.org/10.4018/978-1-7998-9247-2.ch003

Watanabe, A. (2023). Exploring totalitarian elements of artificial intelligence in higher education with Hannah Arendt. *International Journal of Technoethics*, 14(1), 1–15. https://doi.org/10.4018/IJT.329239

Watanabe, A., & Schmohl, T. (2021). How can students explore critical thinking as an academic practice. *New Perspectives in Science Education*, 10, 150–154. https://doi.org/10.25656/01:27943

Weißpflug, M. (2019). *Hannah Arendt: Die Kunst, politisch zu denken.* Matthes & Seitz.

Zawacki-Richter, O., Marín, V., Bond, M., & Gouverneur, F. (2019). Systematic review of research on artificial intelligence

applications in higher education –: Where are the educators? I*nternational Journal of Educational Technology in Higher Education*, (16), Article 391–27. https://doi.org/10.1186/s41239-019-0171-0

PART II

SECTION II: REFLECTIONS ON METHODOLOGIES AND METHODS

This section, which consists of three chapters, aims to give readers insights into a variety of methodologies and methods for SoTL research. The first chapter is a research article that addresses faculty learning. It is a qualitative study, but it also addresses quantitative research methods through the discussion of learning analytics. Further, as suggested in **Chapter 4**, there is often more to be learned from SoTL studies than what is typically reported in a research article. Therefore, the next two chapters are reflective essays where authors describe lessons learned from their previously published SoTL work.

In **Chapter 6: What's the Big Deal about Big Data? Learning Analytics and the Scholarship of Teaching, Learning, and Student Success**, Charmian Lam, George Rehrey, Linda Shepard, Michael Sauer, and Jeremy Herhusky-Schneider ask "what's the big deal about big data?" They report on a faculty Fellows program at their institution where faculty are supported to conduct SoTL research using large, complex institutional data sets. By qualitatively analyzing faculty's project completion reports and focus group transcripts, they provide insights not only into how to support faculty to use learning analytics (LA) for SoTL research, but they also provide examples of LA studies and research questions that aim to have impact at the department, program, or institutional level.

In **Chapter 7: Learning to Be "Fearlessly Creative": SoTL Research on Scholarly Digital Storytelling**, Kelly Schrum describes and reflects on a multi-year project which consisted of conducting interviews with 32 students and 25 faculty members about their experiences with digital storytelling plus analysis of their course materials. She describes multiple outputs from the study, including several papers targeted at humanities audiences and multidisciplinary audiences about various aspects of her findings, plus an open educational resource. Included in her "lessons learned" section are her reflections on the efficacy of her interview questions, which she also shares on her website.

Finally, in **Chapter 8: Using Phenomenography as a theoretical framework for investigating student experience with EdTech**, Brett McCollum describes both the framework of phenomenology and his use of it to study student experiences in chemistry. An empirical qualitative methodology, this approach to SoTL would be especially attractive to many faculty coming from a STEM or other positivist backgrounds. Methods are described in detail and the chapter concludes with a useful description of some of the "abysmal failures" that do not typically make it into a research report.

By blending empirical studies with reflective essays, this section not only provides practical insights into qualitative and quantitative approaches but also highlights the hidden complexities and lessons that often go unreported in traditional research articles.

6. What's the Big Deal about Big Data? Learning Analytics and the Scholarship of Teaching, Learning, and Student Success

CHARMIAN LAM; GEORGE REHREY; LINDA SHEPARD; MICHAEL SAUER; AND JEREMY HERHUSKY-SCHNEIDER

Introduction

During the past decade, the use of learning analytics (LA) in higher education has evolved from an emergent field to a well-established aspect of higher education's ecosystem (Lodge et al., 2019). The purpose of this chapter is to inform SoTL practitioners about how they could use LA to expand the possibilities of what can be known about their students and curriculum, connecting their current practices with large, robust, quantitative datasets that provide new kinds of evidence of student learning.

We start by defining LA and student success before providing a brief overview of our Learning Analytics Fellows (Fellows) program (Rehrey et al., 2019; Shepard et al., 2019). What follows is an overview of organizational change as our theoretical framework. We then share the results of a qualitative analysis of the program, the limitations of our study, and a discussion about its implications. We conclude by recommending evidence-based steps that educators and educational technologists could take to use LA in their SoTL projects.

The difficulty with finding a term that captures how massive and complex datasets are being employed in higher education rests with how fast the field has grown and evolved since the term LA was initially defined by the Society for Learning Analytics Research (SoLAR, 2011). For our purposes, we define the term LA to include both learning analytics and academic analytics as originally defined by Long and Siemens (2011). This includes "any and all data that can be analyzed and acted upon to improve student success" (Rehrey et al., 2020, p. 222), and that can be categorized as reported data, automatically recorded data, data derived from other data, and inferred data that makes correlations between datasets (Sclater, 2017). Most LA are derived from the learning management system, but they can also be located in other educational technology tools software, such as polling software.

We use the term student success to mean that "students persist, benefit in desired ways from their college experience, are satisfied with college, and graduate" (Kuh et al., 2017, pg. xii). Thus, students will have experienced purposeful educational activities and attained their own objectives for attending college.

The Learning Analytics Fellows Program

The purpose of the Fellows program is to shift the teaching and learning cultures in departments and programs throughout our institution, moving faculty who are not usually involved in our SoTL program from anecdotal storytelling about their students to one that is quantitative and evidenced-based (Rehrey et al., 2018). From its inception, we understood that departmental-level change would require a long-range plan, like the one advocated for by the Association of American Universities in 2017 that claims systemic departmental change takes 5–7 years to accomplish. Similarly, Corbo et al. (2016) suggested in their findings that the "improvement of higher education requires more than the development of new teaching strategies; it requires systemic, cultural change" (p. 12). Based upon those earlier

findings, we developed our own framework of short-term, mid-term, and long-term program outcomes, with cultural shift as the ultimate goal (**Figure 6.1**).

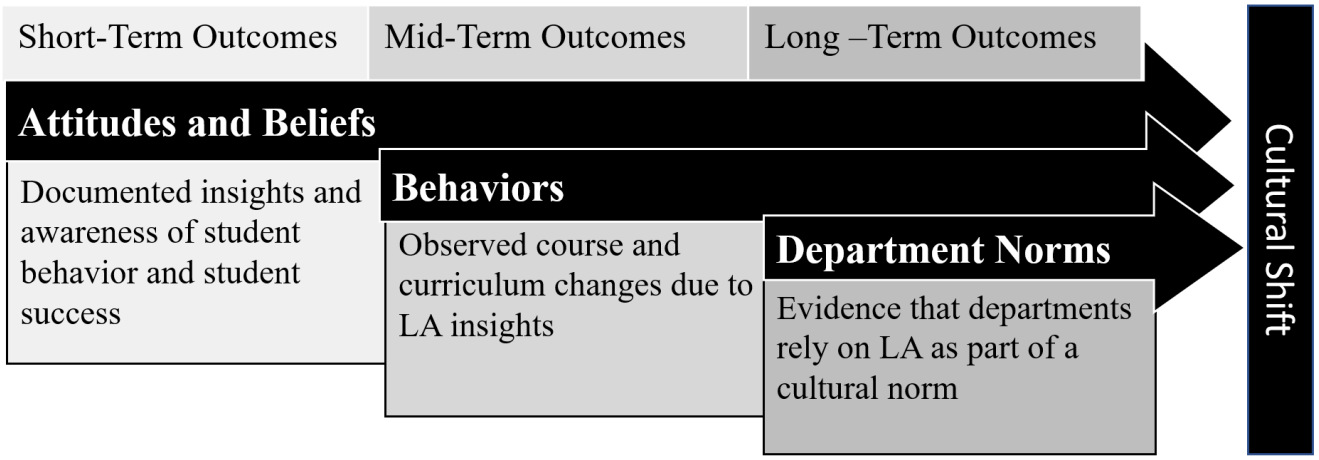

Figure 6.1 *Learning Analytics Cultural Shift Framework [Long Description available]*

Cultural change in higher education is difficult to study due to a unique combination of "decentralized structures, institutional status and image, shared governance, and the often-conflicting interests of various stakeholders" (Kezar, 2001, p.vi, p.55). However, the first step to change is to examine how institutional culture and type may influence potential change (Kezar & Eckel, 2002). Established in 2015, the Fellows program was originally modeled after the SoTL grants program at Indiana University Bloomington (IUB), which is a large, public, selective institution with very high research activity in the United States (Carnegie Classifications, 2024). Over the past 7 years, Fellows have represented a diverse cross-section of the IUB teaching and learning community (**Figure 6.2**). Fellows join the program voluntarily by submitting a proposal indicating their research questions and what they hope to accomplish in the coming year.

Figure 6.2 *Visualization of program fellows by university roles [Long Description available]*

Typically, our LA Fellows conduct SoTL research using large complex datasets. Instead of studying a small number of courses or students over a relatively limited time span, Fellows have access to tens of thousands of (anonymized) student records and all the courses taught at IUB, spanning over a decade. The data is from our student information systems warehouse, rather than learning management systems (LMS). The datasets provided to Fellows represent the student's academic experience, including variables about admissions such as academic preparation (e.g., high school GPA, SAT/ACT), data about student academic progress (coursework, major transitions, grades), demographic information (e.g., gender, ethnicity, residency), and some information about student life (e.g., residential programs, student activities, student associations), student economic status, and student outcomes (degree information, job placement). This data is cleaned, anonymized, and provided by our institution's assessment and research unit.

As an example of what can be accomplished, one of the Fellows' projects concerned the records of approximately 31,192 undergraduate students enrolled at IU-Bloomington in the Spring semester of 2020. In their project, *Satisfactory Grade Option: Choice Determinants and Consequences*, Xiao and Kaganovich (2020) analyzed 130,725 grade records. Their project analyzed the outcomes of IUB's unique grading policy option that was made available to students in the spring semester of 2020. To mitigate the disruptions from the emergent pandemic, students were given the option to replace their standard letter grade with an "S" (satisfactory). Results from five different sets of multinomial logistic regressions found that students with a lower prior GPA before the pandemic were more likely to choose "S" in each course they enrolled in. This finding was contrary to the notion that the adverse effect of a given letter grade in a Spring 2020 course would be more detrimental to a student with a higher prior GPA.

Figure 6.3 illustrates what we have observed with the Fellows over time, as they move from the micro (course) to the mega (institutional) level (Poole & Simmons, 2013) with their scholarly research. This aligns with another goal of the program—to expand the scope of SoTL projects, providing opportunities for faculty to become aware of how they influence and affect student performance and success beyond what occurs in their individual courses and programs. The left pane illustrates the relatively shallow idea of what happens to students after a course that faculty may hold about students in large introductory courses. There is even less knowledge of what happens to students throughout their college career as they make significant and potentially life-long decisions.

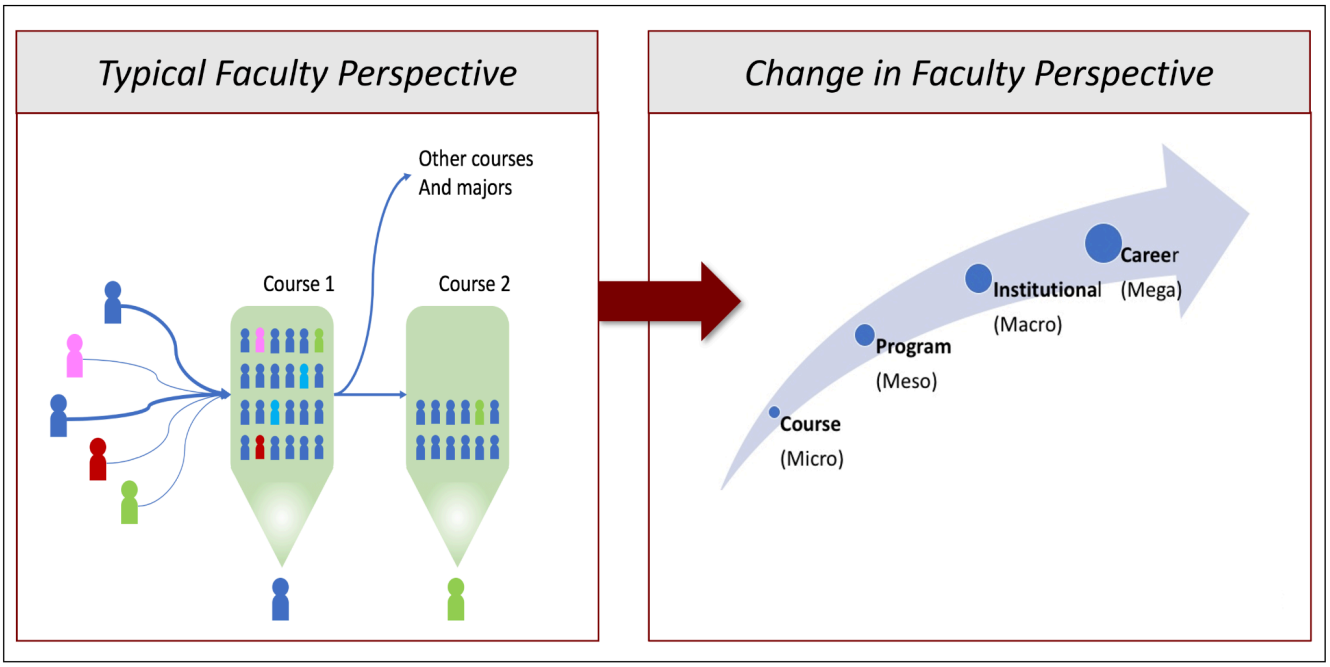

Figure 6.3 *Expanding the impact of SoTL through a change in faculty perspective. [Long Description available]*

After we introduced LA to the SoTL practitioners on our campus, faculty were able to better use statistical results and data visualizations to holistically understand factors and patterns of student behaviors beyond the classroom (Rehrey et al., 2019). Interest in patterns of student behavior can be observed in the types of research questions that were asked in faculty projects. This included interest in student performance in upstream and downstream courses, in required courses outside their major, as well as comparisons in student performance in difficult science courses compared to their overall performance in all the other coursework. These observations stemmed from our roles as LA and SoTL facilitators, and this study was designed to identify empirical evidence while acknowledging our research subjectivity and delving deeper into how LA and SoTL may shift teaching and learning academic culture. Our approach and research questions were also informed by the following theoretical framework and research methodology.

Research Paradigm and Theoretical Framework

Kezar and Eckel (2002) recommended that organizations realize their own institutional culture through self-discovery. Following a cursory Fellows program review as part of routine administration in the previous section, we, therefore, designed this study for a deeper understanding of how SoTL, infused with LA data, can change teaching and learning cultures in academic programs. Kezar's work on organizational change was used to frame our understanding of the structures and mechanisms that influence and prevent institutional change.

The critical realist perspective best aligned with our understanding of the research site and our theory of change (**Figure 6.1**). This perspective allowed us to consider the multifaceted nature of an organization's cultural change, accounting for both measurable outcomes and the nuanced, subjective realities of individuals within the institution (Bogna et al., 2020). The measurable program outcomes discussed in the previous section (e.g., number of faculty Fellows participating and completed research projects) were surface-level observations that reflected the myriad influences of institutional structures and mechanisms that drive or resist change. These outcomes, structures, and mechanisms are simultaneously heavily influenced by social, cultural, and individual interpretations of working with big data and the value of SoTL research. In our study, we sought to more empirically review the Fellows' research projects while complicating our understanding with subjective, individual perceptions of comfort with using big data and the value of SoTL research. A critical realist perspective best reflects our conception of how LA-informed SoTL projects may influence teaching and learning cultures because it supports examinations of subjective, social actors in the context of systems that constrain and facilitate their agency (Miller-Young, in press). However, an empirical qualitative approach was taken for this particular study (neopositivist inductive paradigm, see **Chapter 2**).

Next, Kezar's work on organizational change was most influential in considering the institutional factors at play in higher education that may influence how individual choice to pursue LA-informed SoTL research affects cultural change in teaching and learning. Kezar (2001) also underscored the importance of integrating empirical research with deep knowledge of institutional culture and human agency. Successful, sustainable change requires an understanding of both structural and cultural dimensions of institutions. Kezar (2001) argued that change is inherently complex within higher education due to unique factors such as shared governance, decentralized structures, and the diverse goals of faculty, staff, and administrators. As such, initiatives that promote change should be adaptable, context-specific, and inclusive of multiple perspectives, rather than those that are top-down and generic (Kezar, 2001, p. 123).

Though this study is not an exhaustive and comprehensive review of institutional factors that promote or resist change, we analyzed our data within the context of our own institutional culture. Our positions as facilitators of big data, LA-informed SoTL was an asset, given Kezar's empowering focus on promoting specific, context-dependent change through an understanding of the institutional culture within.

Research Questions

We sought answers to the following questions about the Fellows program:

- What kinds of LA projects do faculty propose and how do they change over time with repeat participation in SoTL projects using big data?
- How do faculty describe their experience in the LA Fellows Program?

Research Methods

We took a qualitative, empirical approach to this study (Yeo et al., 2023). Our questions were addressed by collecting and analyzing two sources of data: project completion reports and focus group transcripts. All data was collected and managed using appropriate confidentiality and ethical guidelines as approved by the university's institutional review board.

Data Generation

First, all fellows (2015–2021), as a regular step in finishing the program, completed a summary report of their findings and reflections on the impact of using LA data on their research and teaching practices. These reports were used as a data source to understand how faculty were using the data and the types of questions that were being addressed (n = 57 reports). Faculty reports were analyzed using content analysis (Yeo et al., 2023). Each faculty report was coded independently by two authors and then compared and discussed until agreement was reached to increase inter-researcher reliability (Lattuca & Domagal-Goldman, 2007). The coding categories were: faculty discipline, number of students in sample, whether faculty were repeating participants (y/n), the scope of their research (classroom, departmental, institutional, or regional), topics of research project (32 categories), student learning outcomes investigated in the study (18 categories), variables in the study (47 categories), study research methods (3 categories), study outcomes (5 categories), and themes from their reflection on participating in the LA Fellows Program. By aggregating faculty reports across seven cohorts, we added reliability to inferences about influential components of the LA fellowship on shifting teaching and learning cultures.

Second, three focus groups were conducted by the research team with a subset of volunteer participants (n = 7) to gather information from the Fellows about their experiences in the program and hear details about the benefits and barriers surrounding their participation. The sessions were audio-recorded and transcribed for analysis. Transcripts were analyzed using empirical thematic analysis (Braun & Clarke, 2006). Each researcher read and coded all three transcripts with RQ2 in mind. Two researchers then collated the codes into relevant themes that answered RQ2.

Data Analysis

In the analysis of both the focus groups and the faculty reports (discussed in the next paragraph) where we encountered challenges regarding inter-rater reliability, we used several rounds of group norming to agree on specific definitions for some concepts and variables. We held meetings during which we discussed our understanding of each code, and each reviewer re-examined their previous codes and made changes accordingly. Resolving our initial differences in code constructs resulted in overall greater clarity and confidence in results.

Results

Between 2015 and 2021, 69 research teams engaged in Fellows' research, 12 teams had not submitted a completion report at the time of this study, and we have 57 completion reports. It is possible for multiple faculty members to collaborate on a single project and faculty can participate for multiple years. **Table 6.1** provides a summary

of the data that Principal Investigators provided in their faculty reports: their academic discipline, and scope of their research or focus of their project outcomes.

Table 6.1 ***Description of Learning Analytics Fellows Program (2015–2021)***

Totals	**Count**	**%**
Total Unique Participants	69	100
Total Projects in Study	57	100
Project Discipline	**Count**	**%**
Academic Support	7	12.28
Business	8	14.04
Humanities	12	21.05
Professional Schools	6	10.53
Social Science	17	29.82
STEM	7	12.28
Project Scope	**Count**	**%**
Course	20	35.09
Departmental/Program	23	40.35
Institutional	13	22.81
Regional and Up	1	1.75

Completion Report Results

Not all Fellows' projects contained research questions, but all contained the topics of study, the educational outcomes studied, and the methods. Codes in the faculty completion reports (n = 57) represented the main topic of the project, the educational outcomes that were studied, and their plans of action following participation in the program. The top three topics regarding teaching, learning, and student success were academic performance defined as grades/GPA (n = 37); effectiveness of a course curriculum (n = 20); and student choice of major (n = 19).

One example of the first topic, academic performance defined as grades/GPA Factors, was a project completed in 2020 titled "Determining Student Success in Downstream Courses from Business Statistics." The study was classified as "departmental/programmatic" level by the authors of this chapter. Data about 3,000 undergraduates on their resident status (in/out of state), gender, Pell grant recipient status, first or multi-generation status, student final course grades, and source of course prerequisites (standardized exams, community college credit or same-institutional credit) was used in this study. One course-level project from 2016 on the effectiveness of a course curriculum topic was titled "The Impact of "Becoming the Best Student" and "You@IU" Courses on Retention, Graduation, GPA, and Student Lives More Generally." In it, the researcher analyzed data from 4,780 undergraduates about their ethnicity or race, gender, international residency status, major, Pell grant recipient status, first or multi-generational status, and final course grades. One institutional-level project from 2020 on the topic of student choice of major was "Grade Expectations in Introductory Courses and the Effects on the Corresponding Majors." Data from 17,890 undergraduates on their course grades, choice of major, college GPA, course selections, in-state residency status, ethnicity or race, gender, timing of changes of major, Pell grant recipient status, and first or multi-generational status were used in this project.

The top educational outcomes included course grades including Drop, Fail, and Withdrawals (DFW) (n = 28); college GPA (n = 19); and retention (n = 11). Faculty reports included plans of action following the fellowship year. The

most common outcomes of participation in the program were sharing with colleagues in both formal meetings and informal conversations, proposals for future studies (in subsequent years in the program and externally), a presentation of findings at a conference, and/or data-informed curricular redesign.

Projects that concern diversity, inclusion, and equity (DEI) were reflected in half of the faculty reports. Of all the coded reports (n = 57), 20 reports either explicitly mentioned or implied relevance to DEI issues, seven featured DEI as a foundational part of their study, and 26 did not include DEI. An aggregated account of 27 reports studied a variety of DEI topics, such as financial need, international student status, race, and gender gaps in classroom performance (e.g., grade distribution, exam performance), retention in the major/program, and post-graduate job outcomes. DEI issues were consistently present in all program years (2015–2021). Nine out of 10 projects in STEM fields included or mentioned DEI.

Of note are the evolution of projects from faculty who participated multiple times (**Table 6.2**). Thirty faculty served as PIs to 57 projects; 15 PIs participated at least twice. These faculty tended to refine their topics and evolve their understanding of student learning. More specifically, faculty had more broad, exploratory topics in their initial year(s) and then dove deeper into topics with specific variables in subsequent years. Some even expanded impact levels from micro (individual level) to macro (institutional level) (Poole & Simmons, 2013) as their involvement in the Fellows program progressed. Given the constraints on space, **Table 6.2** provides project details for three representative faculty who were selected based on diversity of fields (social science, humanities, and business), and they were among those who participated the most years in a row.

Table 6.2(a) ***Evolution of Faculty Member's Projects Over Multiple Years — Faculty A in Social Science***

Year	Title	Impact Level
2016	Determinants of Students' Choices of Undergraduate Majors and Programs' Strategies: The Factors of Differential Grading Standards across Academic Units	Departmental/Program
2017	The Factors of Differential Grading Standards across Academic Units	Departmental/Program
2018	Gender Differences in Persistence in a Field of Study	Institutional
2019	Changing Course or Dropping out: the Gender Factor	Institutional
2020	Means and Ways: the Interaction of Family Income and Gender in Academic Field Selection and Persistence	Institutional

Table 6.2(b) ***Evolution of Faculty Member's Projects Over Multiple Years — Faculty B in Humanities***

Year	Title	Impact Level
2017	Exploring relationships between the New Indiana Academic English Test (IAET) and External Measures	Institutional
2018	Examining the consequential validity of the new online Indiana Academic English Test (IAET)	Institutional
2019	Exploring determinants of international students' academic performance using longitudinal data analysis	Institutional
2020	Improving placement accuracy and efficiency of incoming international students into ESL support courses	Institutional

Table 6.2(c) ***Evolution of Faculty Member's Projects Over Multiple Years — Faculty C in Business***

Year	Title	Impact Level
2017	The Factors to and Impact of [300-level business course] Success	Course
2018	Finding the Keys to Success in Business [200 level course]	Departmental/Program
2019	Major Declaration and Degree Earned in [Business] School in 12 Years	Departmental/Program
2020	Major Switchers and Course Enrollment	Departmental/Program
2021	Can Degree Earned Be Predicted?	Institutional

Focus Group Results

Results from focus groups (n = 7) provide insights into each of the research questions. The most prominent themes highlighted here relate to how and to what extent the lens offered by LA contributes to a culture of evidence-based teaching and learning practices. **Figure 6.4** summarizes the results of the Fellows' comments. Three critical themes frame the faculty experience when provided with LA for their research. First, Fellows describe their initial belief in the power of the data, the 'a-ha' moment, of how the results of their research were explained by the data. Second, Fellows describe how the program influenced their professional trajectory for continued participation, or continued alignment with this approach. Was the change in beliefs sustainable? Third, Fellows describe an affinity to the community of Fellows and discuss the role of this community. This theme is most prominent among those who have participated multiple times or remain connected to the Fellows community.

In the first theme, we found that participants reported growth and change in personal attitudes. They cite an "awareness" or "awakening" about how data can be used to inform teaching practices and learning experiences. Some respondents note they previously relied on "myths" about teaching and learning. The projects led to discussions that covered many levels of influence, e.g., changes in course pedagogy, curriculum flow, major changes, and student success at the campus level. One respondent commented that "…it allows me time to figure out what the questions are and allows those questions to develop over time." Another Fellow summed up the potential for using LA by saying "It was a game changer for us to figure out what's going on in our classes." The faculty experienced these changes due to administrative support to improve undergraduate education, which provided data and analytical assistance from institutional research.

These personal changes were described as "impactful" or "lasting." Faculty reported a desire to propose and evaluate solutions to teaching and learning problems they encountered in their positions. A few participants described an increased comfort with conducting research using student data. Participants also felt more comfortable with quantitative methods, especially those who were from humanities or otherwise did not have statistical training. Participants described feeling empowered to initiate research or refine existing research projects about teaching and learning after their fellowship year. From our provision of analytical support, these outcomes are possible due to institutional support; however, faculty continue to be comfortable in their subsequent usage of data. Comments faculty made in the focus groups supported our findings and demonstrated optimism for improving teaching and learning because of undertaking LA-informed SoTL projects. As one fellow said, "We gain confidence, and the ability to put the microscope on ourselves and our programming."

Lastly, participants discussed how the Fellows community was personally and professionally rewarding. They disseminated work in formal settings (e.g., conferences, departmental meetings) and informal settings (e.g., emails, "hallway chats"). As one fellow stated, "I got involved with the Fellows program because someone in my department

mentioned this program." In discussing someone else's project, a fellow mentioned, "I know there's a lot of effort being put now into trying to figure out a better path for our students who are less prepared. And I think that does come from the study that you did." Collaborations across departments have been supported by our program and organically emerged through Fellows' social networks. One Fellow mentions the connections and collaborations he, as an expert in learning sciences, has had with STEM faculty who manage large, difficult classes that are required for STEM and other majors. He stated, "Extended collaborations really need to happen to have this kind of impact. I think these are important for improving pedagogy throughout the University." Faculty also reported recruiting one another to participate in the LA Fellows program in subsequent years.

Overall, Fellows felt more comfortable and confident about working with big data derived from LA. Fellows who participated for multiple years tended to focus on classroom-based, micro-level outcomes in the early years and departmental- or institutional-level outcomes during the later years.

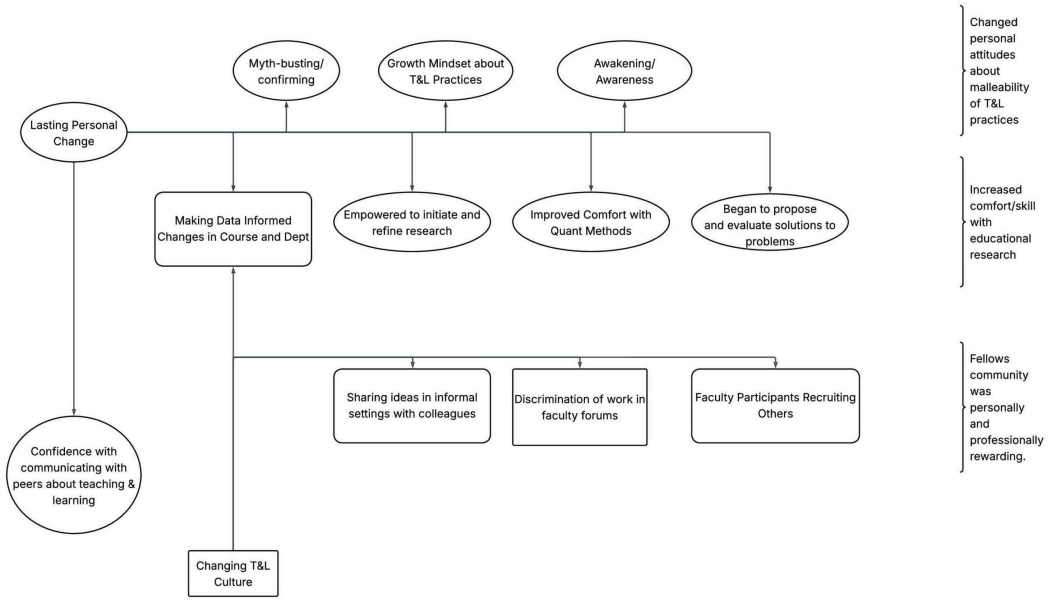

Figure 6.4 *Salient codes and themes from the focus groups (n = 7): the flow chart shows two main codes, one in oval and one in rectangle, with the intersections in subcodes shown in rectangles with rounded corners. Three overarching themes from the codes are represented in brackets. [Long Description available]*

Limitations

Faithfully addressing the limitations of this study helps to limit the overreach of findings. First, this study describes one program's attempt to leverage an existing SoTL program's successful practice to expand and transform the teaching and learning culture at one institution. Second, several program participants did not submit a final summary report, despite receiving requested data and analytical assistance. It was not possible to account for these faculties' experiences, findings, and potential difficulties in our analysis, possibly biasing our results. Lastly, due to availability in schedules, the focus groups were facilitated by individuals whose institutional roles included administration of the fellowship program. This choice may have biased the focus group respondents' responses. Additionally, we may never know the experiences of faculty who chose not to participate in focus groups.

The evaluation of the program would benefit from other perspectives. For example, asking department chairs or deans what they know about the program and if the faculty are encouraged to participate, etc. Talking to the administrators of the program or faculty who have attended information sessions about the program but never participated may reveal barriers experienced by some faculty before they even write a proposal.

Discussion

A culture shift that supports evidenced- informed teaching and learning practices as a departmental norm requires time to mature within a large department or at a campus with ~35,000 undergraduate students. The LA Culture Shift Framework (**Figure 6.1**) presents a heuristic for observing the development of this data-informed culture. In the short term, faculty begin to engage with the LA data as they conduct SoTL. Faculty in the mid-term see the value of their inquiry and respond to the findings by inquiring further, making decisions about new approaches, sharing their work, and/or encouraging others to participate. Finally, in the long term, the framework suggests that work is embedded into a departmental culture as a departmental norm. At this stage, departments expect faculty to be involved in research or a service that improves the success of their students. Departments establish a culture where faculty engage in dialog about their findings and where teaching practices are consistently informed by the evidence of effectiveness obtained by the use of institutional data.

Faculty participating in course-level or departmental level research on student success were the most common in all the years of the program. At the departmental level, Fellows examined factors that influenced the choice of major as well as program retention and recruitment. The Fellows who initiated department-level projects had some administrative responsibilities as part of their faculty position. Diversity, equity, and inclusion were consistent interests across all program years and mostly concerned ethnicity and gender.

Based on the LA Culture Shift framework, Kezar's work on organizational change, and our data, our findings show progress towards our ultimate goal to shift teaching and learning cultures in academic programs within higher education using LA-informed SoTL projects. Prior to participating in the LA Fellows Program, faculty were more likely to consider student learning from a course-based perspective (**Figure 6.3**). We found that faculty gained confidence and comfort with working with large data, which will increase the likelihood of their self-driven research into student success in the future. Without data cleaning, preparation, and some coaching in manipulation and visualization, certain fellows expressed disbelief in their ability to conduct their project. Faculty focus group responses also revealed a tendency to be more reflective about their teaching practices after using big data. Comfort in working with large quantitative data was especially important for faculty from the humanistic disciplines or those who were trained as qualitative methodologists. Additionally, Fellows shared their participation in our program and their project's results in faculty meetings, informal hallway conversations, and professional venues such as conferences. By doing so, faculty were able to recruit their colleagues for subsequent projects with this program, or, at the very least, highlighted the use of LA with their colleagues within and across their departments.

Implications

Becoming comfortable using LA is not trivial, even considering those with experience in quantitative data analysis. The faculty demonstrated a wide range of levels of comfort and experience working with large operationally derived datasets. Some faculty required little support other than the documentation accompanying the datasets available to them and occasional answers to questions about specific variables and how to interpret them. For others, the use and analysis of datasets was a completely novel and sometimes uncomfortable or intimidating experience, and they relied heavily on our assessment and research unit to guide and perform their analysis. This included: joining the institutional datasets to their locally maintained datasets; producing descriptive data visualizations to explore and analyze the data; using propensity score matching to select comparison control populations; and performing ANOVA, linear regression, and logistic regression analyses. They also received assistance with the interpretation of analyses performed when requested.

By its very nature, the support required for SoTL practitioners to obtain and analyze LA is contextual. Every institution has its own formal and informal policies and practices for where, when, and how the data is stored and who controls access to it. Additionally, each country has its own laws about data storage and privacy that consider the security and ethical practices of using personal information for any purpose. For SoTL practitioners, the most sensible place to start is with the questions one wants to answer with analytics. If the questions are about course-level engagement and interactions, the data will be most likely derived from the LMS. This requires working with a teaching center or the unit responsible for the LMS. If the questions indicate an interest in students' attributes and performance across a spectrum of time and courses, the data will be stored in a data warehouse, or student information system (SIS). In this case, the institutional research (IR) office and decision support units would be the first points of contact.

Although obtaining and using LA may seem like yet another research obstacle to overcome, we encourage SoTL practitioners to make the effort, enrich their research and understanding of student success, and become partners with other units on their campus that are invested in the transformation of teaching and learning through this new opportunity. For educational technologists, we emphasize the need to connect SoTL practitioners with dedicated staff who are trained in research methodology and quantitative methods.

Conclusion

As LA becomes an increasingly integral part of higher education, it offers expansive opportunities for both SoTL practitioners and educational technologists to improve student success at the intersections of technology and pedagogy. The Learning Analytics Fellows Program illustrates that, with institutional support and access to comprehensive data, faculty Fellows can gain deeper insights into student behavior and success while promoting effective evidence-based teaching. This shift required ongoing support to build confidence, especially for faculty less familiar with quantitative data or big data analysis. A structured approach—focused on fostering LA skills and creating cross-disciplinary collaborations—can empower educators to explore the broader impacts of their teaching practices and address complex questions about student success that transcend individual classrooms.

A conclusive answer to whether LA-informed SoTL projects may shift teaching and learning cultures at the departmental and institutional levels may be possible in the future. We found that faculty comfort with manipulating large datasets and how faculty Fellows communicate about their projects are two outcomes that have the potential to change culture. This finding aligns with Kezar's (2001) work on how sustainable change occurs in institutions of higher education. A shift toward departmental and institutional support for evidence-informed teaching and learning requires time, influential individuals in administration, and grassroots-based movements to change (Kezar, 2001). To start, we encourage reflecting on your own teaching practices with SoTL or big data with the following questions.

Reflective Questions

- How do you currently use learning analytics?
- Given your own preferred research paradigm(s), how might large-scale data from learning analytics support your exploration of student learning, instructional effectiveness, or curricular improvements?
- What steps can you take to become more comfortable with analyzing and interpreting large data sets?

References

Association of American Universities. (2017). *Progress toward achieving systemic change: A five-year status report on the AAU undergraduate stem education initiative* [PDF]. https://www.aau.edu/sites/default/files/AAU-Files/STEM-Education-Initiative/STEM-Status-Report.pdf

Bogna, F., Raineri, A., & Dell, G. (2020). Critical realism and constructivism: Merging research paradigms for a deeper qualitative study. *Qualitative Research in Organizations and Management: An International Journal*, 15(4), 461–484. https://doi.org/10.1108/QROM-06-2019-1778

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Carnegie Classification of Institutions of Higher Education. (2024). *Indiana University-Bloomington*. https://carnegieclassifications.acenet.edu/institution/indiana-university-bloomington/

Corbo, J. C., Reinholz, D. L., Dancy, M. H., Deetz, S., & Finkelstein, N. (2016). Framework for transforming departmental culture to support educational innovation. *Physical Review Physics Education Research*, 12, Article 010113. https://doi.org/10.1103/PhysRevPhysEducRes.12.010113

Felten, P. (2013). Principles of good practice in SoTL. *Teaching & Learning Inquiry*, 1(1), 121–125. https://doi.org/10.2979/teachlearninqu.1.1.121

Kezar, A. J. (2001). *Understanding and facilitating organizational change in the 21st century: Recent research and conceptualizations* (Vol. 28) [PDF]. Jossey-Bass. https://files.eric.ed.gov/fulltext/ED457711.pdf

Kezar, A., & Eckel, P. D. (2002). The effect of institutional culture on change strategies in higher education: Universal principles or culturally responsive concepts? *The Journal of Higher Education*, 73(4), 435–460. https://doi.org/10.1080/00221546.2002.11777159

Kuh, G., O'Donnell, K., & Schneider, C. G. (2017). HIPs at ten. *Change: The Magazine of Higher Learning*, 49(5), 8–16. https://doi.org/10.1080/00091383.2017.1366805

Lattuca, L. R., & Domagal-Goldman, J. M. (2007). Using qualitative methods to assess teaching effectiveness. New Directions for Institutional Research, 2007(136), 81–93. https://doi.org/10.1002/ir.233

Lodge, J. M., Horvath, J. C., & Corrin, L. (Eds.). (2019). *Learning analytics in the classroom: Translating learning analytics research for teachers* (1st ed.). Routledge.

Long, P., & Siemens, G. (2011). Penetrating the fog: Analytics in learning and education. *Educause*, 46(5), 31–40. https://er.educause.edu/articles/2011/9/penetrating-the-fog-analytics-in-learning-and-education

Miller-Young, J. (in press). Asking "how" and "why" and "under what conditions" questions: Using critical realism to study learning and teaching. *Teaching and Learning Inquiry*.

Poole, G., & Simmons, N. (2013). Contributions of the scholarship of teaching and learning to quality enhancement in Canada. In R. Land & G. Gordon (Eds.), *Enhancing quality in higher education*. Routledge.

Rehrey, G., Groth, D., Shepard, L., Fiorini, Stefano, & Hostetter, Carol. (2018). Implementation of a student learning analytics fellows program. In A. Pardo, K. Bartimote, G. Lynch, S. Buckingham Shum, R. Ferguson, A. Merceron, & X. Ochoa (Eds.), *Companion proceedings of the 8th international conference on learning analytics & knowledge* (pp. 1–9). Society for Learning Analytics Research. http://bit.ly/lak18-companion-proceedings

Rehrey, G., Groth, D., Shepard, L., & Hostetter, C. (2019). The scholarship of teaching, learning and student success: Big data and the landscape of new opportunities. In J. Friberg & K. McKinney (Eds.), *Applying the scholarship of teaching and learning beyond the individual classroom level* (pp. 182–200). Indiana University Press. https://doi.org/10.2307/j.ctvpb3w0t.13

Rehrey, G., Molinaro, M., Groth, D., Shepard, L., Bennett, C., Code, W., Reynolds, A., Squires, V., & Ward, D. (2020). Supporting faculty adoption of learning analytics within the complex world of higher education. In D. Gibson & D. Ifenthaler (Eds.), *Adoption of data analytics in higher education learning and teaching* (pp. 221–238). Springer. https://doi.org/10.1007/978-3-030-47392-1_12

Sclater, N. (2017). *Learning analytics explained*. Routledge.

Shepard, L., Rehrey, G., Groth, D., & Reynolds, A. M. (2019). Evaluating a learning analytics research community: A framework to advance cultural change. In A. Pardo, K. Bartimote, G. Lynch, S. Buckingham Shum, R. Ferguson, A. Merceron, & X. Ochoa (Eds.), *Companion Proceedings of the 9th International Conference on Learning Analytics & Knowledge*. Society for Learning Analytics Research.

Society for Learning Analytics Research. (2011). *What is learning analytics*? https://www.solaresearch.org/about/what-is-learning-analytics/

Xiao, R., & Kaganovich, M. (2020). *Satisfactory grade option: Choice determinants and consequences* [Learning analytics completion report]. Indiana University.

Yeo, M., Miller-Young, J., & Manarin, K. (2023). *SoTL research methodologies: A guide to conceptualizing and conducting the scholarship of teaching and learning*. Taylor and Francis. https://doi.org/10.4324/9781003447054

Media Attributions

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Long Descriptions

Figure 6.1 Long Description: Short-term outcomes in attitudes and beliefs—Documented insights and awareness of student behavior and student success; Mid-term outcomes in behaviors—Observed course and curriculum changes due to LA insights; Long-term outcomes in department norms—Evidence that departments rely on LA as part of a cultural norm. [Return to Figure 6.1]

Figure 6.2 Long Description: The pie chart is separated into the following categories:

- Tenure and Tenure Track: 41%
    - Professor: 19%
    - Associate Professor: 13%
    - Assistant Professor: 6%
    - Emeritus: 3%
- Non-Tenure and Tenure Track: 36%
    - Senior Lecturer: 19%

    - Lecturer: 14%
    - Adjunct: 3%
- Staff, Graduate Employees, and Administrators: 23%
    - Coordinator: 7%
    - Director of Undergraduate Studies: 4%
    - Librarian: 3%
    - Graduate Student: 3%
    - Graduate Instructor: 3%
    - Data Analyst: 1%
    - Post-Doc: 1%]

[Return to Figure 6.2]

Figure 6.3 Long Description: The typical faculty perspective is that students attend a large introductory course and then move onto either the next applicable course or other unrelated courses and majors. Faculty do not consider students' patterns and behaviours beyond the classroom.

After introducing SoTL, the faculty perspective changes to consider the students' patterns and behaviours both in and beyond the classroom. These changes can be classified as follows (from smallest to largest): course (micro), program (meso), institutional (macro), and career (mega).

[Return to Figure 6.3]

Figure 6.4 Long Description: Salient codes and themes from the focus groups include:

- Oval codes:
    - Lasting personal change, which leads to confidence in communicating with peers about teaching and learning
    - Myth-busting/confirming
    - Growth mindset about T&L practices
    - Awakening/Awareness
    - Empowered to initiate and refine research
    - Improved comfort with quant methods
    - Began to propose and evaluate solutions to problems
- Rectangle codes:
    - Changing T&L culture
    - Dissemination of work in faculty forums
- Rounded rectangle codes:
    - Making data-informed changes in course and dept
    - Sharing ideas in informal settings with colleagues
    - Faculty participants recruiting others]

[Return to Figure 6.4]

7. Learning to Be "Fearlessly Creative": SoTL Research on Scholarly Digital Storytelling

KELLY SCHRUM

Introduction

Many SoTL projects begin with a problem (Bass, 1999, 2020). After teaching an interdisciplinary, graduate-level course on scholarly digital storytelling for more than a decade, however, I instead had many questions. In this course, I witnessed high student engagement with both content and technology as students developed digital, research, and communication skills. They were proud of their digital stories and shared them professionally and personally, reaching beyond the classroom and traditional academic silos (Schrum et al., 2022). Something positive was also happening for me as an instructor. Every time I taught the course, I expanded my own digital, academic, creative, and pedagogical skills, finding myself challenged—in the best possible ways—to engage deeply with student projects and solve unanticipated problems. Students talked about the experience of finding their voice and reimagining their approach to learning. One reflected, "It's not really about getting that A or A+. It's really about making mistakes and being fearlessly creative." What fostered this enthusiasm and passion for learning? What led to a willingness to embrace new forms of communication and engagement? I wanted to understand what was happening as well as how and why. I also wanted to know if similar things were happening in other classrooms that incorporated scholarly digital storytelling across disciplines, institutions, and even continents.

To begin this work, I started with a definition. The phrase "digital storytelling" was often used to describe personal or community stories (Jamissen et al., 2017). I crafted the phrase "scholarly digital storytelling" to differentiate what my students were doing as they experimented with new forms of academic communication, blending research with storytelling to share their work across media and to reach new audiences (Schrum, 2021). In my graduate course at a large, public, research-intensive institution in the mid-Atlantic region of the United States, students individually created 10-minute digital stories or a non-linear equivalent based on their discipline, academic interests, digital skills, and professional goals. A history student, for example, explored the historical treatment of Filipinos in the Navy while a higher education student researched the experiences of first-generation college students in leadership positions. Topics vary widely, from gender equity in higher education and cross-cultural learning through international branch campuses, women's suffrage, and student parents. Several students have experimented with interactive digital storytelling, including rhetorical structures in open-world games and a Cuban Missile Crisis simulation.

I began to formulate a series of SoTL questions:

- What were students learning?
- What skills did they use after completing this course?
- Would scholarly digital storytelling work across contexts?
- How did faculty at other institutions teach scholarly digital storytelling?
- How did they get started?
- What challenges did they encounter and how did they revise their pedagogical strategies in response?

I also contemplated challenges I might face in conducting this research, including the difficulty of studying something that combined digital skills, content knowledge, and disciplinary thinking. What were effective strategies for assessing student work, for example, across a range of digital skills? With these questions in mind, I embarked on a

multi-year SoTL project using an interpretive, qualitative research approach (Chick, 2018; Miller-Young, 2025) to explore teaching and learning with scholarly digital storytelling from both faculty and student perspectives. The journey allowed me to investigate digital literacy across disciplines and continents and to further develop and refine my methodological approach. It also challenged me in unexpected ways, leaving me even more aware of the need for further research on student learning with educational technology.

Existing Literature

SoTL focuses on teaching and learning, but this is not always true of educational technology research. Castañeda and Selwyn (2018) write that "it is striking how little is known about the relationships between technology use and learning" (2). As discussed in **Chapters 1, 2, and 3** of this volume, SoTL research on educational technology can bridge that gap. Research on digital storytelling has expanded in the years since I began this work. There are now studies from multiple disciplines and teaching contexts (Snelson, 2018). Instructors have documented student engagement with disciplinary learning (Fletcher & Cambre, 2009), intrinsic motivation (Fung, 2017; Gachago et al., 2015; Seraphin et al., 2019), and deeper understanding of content (Schrum, et. al., 2021; Singh, 2014). There is also evidence of faculty resistance or ambivalence (Yi et al., 2020), due in part to concerns over their own technical skills (Belcher, 2017). This theme reappears throughout the literature and Wooley et al. (2021), among others, discussed the need for instructors to "become not just digitally literate (knowing how to use the tools), but also digitally fluent (using the tools in pedagogically authentic ways)" (p. 227). My research also draws from work on digital literacy in higher education (López-Meneses et al., 2020; Oliver & Jorre de St Jorre, 2018). Several recent scoping reviews have used terms such as "video production in content-area pedagogy" (Snelson, 2018), "educational digital storytelling" (Wu & Chen, 2020), and "multimodal composing" (Jiang et al., 2022), although these were not yet common when I started this research. SoTL provides an important lens for this work in a way that emphasizes pedagogically effective integration of technology and meaningful student learning (Felten & Chick, 2018; Manarin et al., 2021; Sweeney et al., 2017).

Researching Student and Faculty Voices

A sabbatical in 2018 provided the opportunity to investigate these questions systematically, a core component of SoTL work (Boyer, 1990; Chick, 2018; Felten 2013). I submitted an institutional review board (IRB) application to my university and, after receiving approval, began reaching out to former students who had taken the course between 2010 and 2018. I conducted 32 individual, semi-structured interviews, reaching roughly half of those who had taken my scholarly digital storytelling class to that point. Interviews ranged from 45 to 60 minutes. I also collected their course work, with permission, including blog posts, project updates, final reflections, and scholarly digital stories, as artifacts of student learning. Interview questions focused on student learning during and after the course, including expectations, experiences creating a scholarly digital story, development of disciplinary understanding and digital skills, advice for future students, and applications beyond the class. I often opened the interview by asking students to describe the digital story they had created and why they took the course, starting with the concrete while offering opportunities for interviewees to share their purpose, goals, process, and reflections looking back on the experience. I asked how their topic or project changed along the way, how the experience compared to learning and assessments in other classes, and whether or not they shared their digital products beyond the classroom.

I then sought out faculty nationally and internationally, across disciplines and teaching contexts, who taught what I defined as scholarly digital storytelling. I wanted to know what they experienced as instructors and what

their students experienced as learners. Using purposeful sampling (Merriam & Tisdell, 2016), I identified potential interviewees in three ways: publications or presentations discussing teaching experiences, conference or workshop attendance related to scholarly digital storytelling, and faculty networks, including colleagues mentioned during faculty interviews. I conducted 25 individual, semi-structured, 45- to 60-minute interviews with faculty who had taught some version of scholarly digital storytelling and 12 of their students. Interviewees represented 20 institutions, 15 disciplines (including education, biology, history, digital arts, medicine, foreign language, and anthropology), six countries (Australia, Canada, Ireland, Norway, United Kingdom, and United States), and a range of types of institutions (e.g., community college, liberal arts, research intensive) and faculty positions (e.g., contingent, term, tenure track, tenured). Many of the faculty interviewed primarily taught undergraduate students, while a few taught graduate students exclusively.

Interview questions focused on faculty goals and experiences teaching with scholarly digital storytelling as well as observations of student learning. I purposefully asked about processes as well as outcomes and challenges and requested syllabi along with examples of successful and less successful final projects:

- Why did they incorporate scholarly digital storytelling into their courses?
- How did they structure the assignments?
- How did their students engage with content, knowledge production, and audience?
- How did faculty assess student learning in a digitally rich environment?

At this point, I had a lot of data—close to 70 interviews as well as sample student course work—and a new question about where to begin the data analysis. I am a historian who teaches in a higher education program in a college of humanities and social sciences. Historical research involves close reading, analysis, and interpretation, and I came to SoTL through digital humanities and a focus on teaching and learning with technology. I am also an interdisciplinary scholar in SoTL where disciplinary methodologies are both encouraged and debated (Chick, 2014; Halpern, 2023). Throughout this research, I drew on these many experiences and methodological perspectives to centre student learning while valuing content knowledge acquisition, digital skill development, and process.

I recorded all interviews (video and audio), so I began with generating transcriptions using Temi, an AI-powered voice-to-text tool. I checked and verified the transcripts and sent them to interviewees for member checking. I coded and analysed all interviews using inductive thematic analysis (Braun & Clarke, 2006; Braun et al., 2019) in DeDoose, a subscription-based web application designed for qualitative and mixed methods research. I followed initial phases of familiarization and code generation with theme development and review (Braun & Clarke, 2006). During this iterative process, I developed additional themes and reviewed the data multiple times for referential adequacy (Nowell et al., 2017). A graduate research assistant reviewed the data independently, and we compared codes and themes. Codes focused on key topics, including academic research, faculty and student experiences, advice for faculty and students, audience, authentic learning, challenges, collaboration, student engagement, scaffolding, and transferable skills.

At the same time, I began reviewing collected course work, primarily from my own students. I coded and analysed written work in DeDoose following a similar process, but the digital work, including multiple iterations of student digital stories, required a different approach (Hafner & Ho, 2020; Jiang et al., 2022; Oskoz & Elola, 2020). I watched and rewatched the stories at different points in their development (e.g., rough cut to final version), looking at content, story, and digital skills. I drew upon my experience in history and digital humanities, including close reading and multimodal thinking, and sought strategies for analysing digitally born work in an effort to identify shifts in student thinking and learning (Lodge et al., 2018). I also examined syllabi and sample scholarly digital stories created by faculty.

The volume and variety of data allowed me to explore teaching and learning with scholarly digital storytelling from multiple angles. Applying an interpretive qualitative research approach (Chick, 2018; Miller-Young, 2025), I gave myself time to explore data from faculty and students organically, including digital stories, and to examine course structures and processes. I reflected on my own experiences and those of my students. In a project focused on

digital scholarly communication, I also considered my desire to share this work publicly both within SoTL communities—through journals such as *Teaching & Learning Inquiry* and the *International Journal for the Scholarship of Teaching and Learning*—and more broadly across disciplinary spaces, such as *Arts and Humanities in Higher Education* and *Higher Education Research and Development*. This helped me shape my writing and think strategically about ongoing pedagogical conversations where this work might contribute, including those cent red on authentic learning, digital literacy, and multimodal communication (Bedenlier et al., 2020; Literat et al., 2018; Morgan et al., 2022).

One article, for example, drew on data from my own courses and focused on cultivating digital skills in the humanities (Schrum, 2022). Results indicated that with careful scaffolding, formative feedback, and student support, scholarly digital storytelling can increase digital agency, problem-solving skills, and knowledge production among graduate students. Another article examined the development of academic and digital research skills, including autonomy, flexible thinking, and multimodal communication, through technology-enhanced assessments (Schrum & Bogdewiecz, 2022). I collaborated with colleagues in Norway and the United Kingdom to explore the potential for scholarly digital storytelling to engage students in authentic learning (Schrum et al., 2021) as well as the impact of audience on student learning, motivation, and skill development (Schrum et al., 2022). I then looked deeply at the experiences of faculty across disciplines and teaching contexts, through interviews and course materials, examining instructor motivations and challenges along with student outcomes (Schrum, 2023). Finally, I created an open educational resource (OER), *Scholarly Digital Storytelling*, to share my teaching materials, research on scholarly digital storytelling, and sample student stories (**Figure 7.1**).

***Figure* 7.1.** *Scholarly Digital Storytelling website*

I relied heavily on student interviews and student work, including scholarly digital stories, when writing about student learning. I then focused on interviews with faculty and analysis of their pedagogical choices, including course design and revisions when teaching with scholarly digital storytelling. While the process of collecting and analysing multiple forms of data from so many different angles provided valuable insight and perspective, it resulted

in a significant amount of content. Some of these sources were easier to analyse than others and, given limitations of time and space, I learned to prioritize depending on the intended audience and publication. I found value in looking at similar forms of data, such as student or faculty interviews, to address some questions. In other cases, looking across the data was most productive, such as reading a student's interview and then examining their course work throughout the semester, from an initial project pitch to a final digital story and student reflection. This process required careful consideration each time I prepared to discuss the research and findings, but it also allowed me to explore the interconnectedness between pedagogy, digital skills, disciplinary content, and student learning across disciplines, geographic locations, and teaching contexts.

Lessons Learned

I learned many lessons along the way, and there are several things I would do differently if I were starting this project today. I took advantage of a sabbatical to begin research on my own teaching and, at the same time, began interviewing other faculty and their students. Given more time, it could have been useful to separate these processes by starting with my institution, reflecting on what I learned, and building on that as I branched out. Beyond interviewing faculty, I would have enjoyed the opportunity to observe them teaching with scholarly digital storytelling in their own classrooms, virtually or in-person, and to have colleagues observe and provide feedback on my teaching. There would also have been value in bringing groups of faculty or students together to discuss their experiences with scholarly digital storytelling and its impact on their pedagogy or learning. I would have liked to interview more students at other institutions about their experiences, including watching student videos with the interviewees to capture their responses in real time. I have seen how valuable this is in my own classes when students watch their rough cuts with classmates and we screen the final works together. As a creator, you see your own work differently when you watch it with an audience and many students and faculty have described similar experiences.

I developed separate interview protocols for faculty and students which allowed me to focus on their different perspectives and experiences with scholarly digital storytelling. The protocols, available on my website, worked well for this research, and I did not revise the questions as I continued through the process. One forward-looking question was especially productive. I asked students what advice they would have for future students encountering scholarly digital storytelling for the first time, and this prompted many interviewees to pause, reflect, and share thoughtful insights about their experiences before reframing them as concrete suggestions. I similarly asked faculty what advice they would have for future students and for other faculty, and both prompts produced meaningful reflection and ideas for what they might change in their own classrooms. Finally, I closed by asking a question I learned from one of my scholarly digital storytelling students: "What didn't I ask?" This has become my favourite interview question and one that I integrate into every research project because it opens up conversations about things I do not know to ask.

Conclusions

Teaching and conducting research on scholarly digital storytelling allowed me to bring together several discrete parts of my academic and professional life, including SoTL, digital pedagogy, and scholarly communication. The research grew in interesting directions, and this book chapter offered a welcome opportunity to reflect on the process and lessons learned. It offered a chance to explore the ways in which SoTL must adapt to the increasingly digital world of higher education by examining the complex blend of technology, pedagogy, and student learning in the post-pandemic classroom. Demand for graduates with digital skills and competencies will continue to grow, and higher education can

play a central role in meeting that need by infusing technology-enhanced learning. Research on SoTL and technology can provide a window into best practices for integrating technology-enhanced learning in organic, meaningful, and productive ways and modeling how we can learn from each other across disciplinary and pedagogical contexts.

Going forward, I hope to see this field expand and encourage others to conduct SoTL research related to educational technology in higher education. There are still many approaches to explore. These include finding creative ways to frame research on technology and learning, thinking broadly, asking big and small questions about teaching and learning within digital spaces, and looking for new ideas and collaborations in unexpected places. Be fearlessly creative and we will collectively improve teaching and learning with technology in higher education!

Reflective Questions

- What do you most want students to learn from a technology-enhanced assessment? Are you focused on digital skills, content, or a combination of both?
- What are effective strategies for assessing student learning in multimodal projects, such as scholarly digital stories?
- How do you evaluate growth in digital skills?
- How might you design a SoTL study that incorporates technology, pedagogy, and student learning? What kinds of questions would you ask?

References

Bass, R. (1999). The scholarship of teaching: What's the problem? *Inventio*, 1(1).

Bass, R. (2020). What's the problem now? *To improve the academy: A journal of educational development*, 39(1), 3–30. https://doi.org/10.3998/tia.17063888.0039.102

Bedenlier, S., Bond, M., Buntins, K., Zawacki-Richter, O., & Kerres, M. (2020). Facilitating student engagement through educational technology in higher education: A systematic review in the field of arts and humanities. *Australasian Journal of Educational Technology*, 36(4), 126–150. https://doi.org/10.14742/AJET.5477

Belcher, D. D. (2017). On becoming facilitators of multimodal composing and digital design. *Journal of Second Language Writing*, 38, 80–85. https://doi.org/10.1016/j.jslw.2017.10.004

Boyer, E. L. (1990). *Scholarship reconsidered: Priorities of the professoriate*. Carnegie Foundation for the Advancement of Teaching.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Braun, V., Clarke, V., Hayfield, N., & Terry, G. (2019). Thematic analysis. In P. Liamputtong (Ed.), *Handbook of research methods in health social sciences* (pp. 843–860). Springer. https://doi.org/10.1007/978-981-10-5251-4_103

Castañeda, L., & Selwyn, N. (2018). More than tools? Making sense of the ongoing digitizations of higher education.

International Journal of Educational Technology in Higher Education, 15, Article 22. https://doi.org/10.1186/s41239-018-0109-y

Chick, N. L. (2014). "Methodologically sound" under the "big tent": An ongoing conversation. *International Journal for the Scholarship of Teaching and Learning*, 8(2), 1–17. https://doi.org/10.20429/ijsotl.2014.080201

Chick, N. L. (Ed.). (2018). *SoTL in action: Illuminating critical moments of practice*. Stylus Publishing.

Felten, P. (2013). Principles of good practice in SoTL. *Teaching and Learning Inquiry*, 1(1), 121–125. https://doi.org/10.20343/teachlearninqu.1.1.121

Felten, P., & Chick, N. (2018). Is SoTL a signature pedagogy of educational development? *To improve the academy: A journal of educational development*, 37(1). http://doi.org/10.3998/tia.17063888.0037.114

Fletcher, C., & Cambre, C. (2009). Digital storytelling and implicated scholarship in the classroom. *Journal of Canadian Studies*, 43(1), 109–130. https://doi.org/10.3138/jcs.43.1.109

Fung, D. (2017). *A Connected curriculum for higher education*. UCL Press. https://doi.org/10.14324/111.9781911576358

Gachago, D., Barnes, V., & Ivala, E. (2015). From consumption to production of knowledge: Using digital storytelling to enhance authenticity of industrial design students' learning. In V. Bozalek, D. Ng'ambi, D. Wood, J. Herrington, J. Hardman, & A. Amory (Eds.), *Activity theory, authentic learning and emerging technologies: Towards a transformative higher education pedagogy* (pp. 181–91). Routledge.

Hafner, C. A., & Ho, W. Y. J. (2020). Assessing digital multimodal composing in second language writing: Towards a process-based model. *Journal of Second Language Writing*, 47, Article 100710. https://doi.org/10.1016/j.jslw.2020.100710

Halpern, F. (2023). The morphology of the SoTL article: New possibilities for the stories that SoTL scholars tell about teaching and learning. *Teaching & Learning Inquiry*, 11(February). https://doi.org/10.20343/teachlearninqu.11.8

Hutchings, P. (2000). Opening lines: Approaching the scholarship of teaching and learning. In P. Hutchings (Ed)., *Opening lines: Approaches to the scholarship of teaching and learning* (pp. 1–10). Carnegie Foundation for the Advancement of Teaching.

Jamissen, G., Hardy, P., Nordkvelle, Y., & Pleasants, H. (Eds.). (2017). *Digital storytelling in higher education: International perspectives*. Palgrave Macmillan Cham. https://doi.org/10.1007/978-3-319-51058-3

Jiang, L., Yu, S., & Lee, I. (2022). Developing a genre-based model for assessing digital multimodal composing in second language writing: Integrating theory with practice. *Journal of Second Language Writing*, 57, Article 100869. https://doi.org/10.1016/j.jslw.2022.100869

Literat, I., Conover, A., Herbert-Wasson, E., Kirsch Page, K., Riina-Ferrie, J., Stephens, R., Thanapornsangsuth, S., & Vasudevan, L. (2018). Toward multimodal inquiry: Opportunities, challenges and implications of multimodality for research and scholarship. *Higher Education Research and Development*, 37(3), 565–578. https://doi.org/10.1080/07294360.2017.1389857

Lodge, J. M., Kennedy, G., & Hattie, J. (2018). Understanding, assessing, and enhancing student evaluative judgement in digital environments. In D. Boud, R. Ajjawi, P. Dawson, & J. Tai (Eds.), *Developing evaluative judgement in higher education* (pp. 70–78). Routledge. https://doi.org/https://doi.org/10.4324/9781315109251-8

López-Meneses, E., Sirignano, F.M., Vázquez-Cano, E., & Ramírez-Hurtado, J.M. (2020). University students' digital

competence in three areas of the DigCom 2.1 model: A comparative study at three European universities. *Australasian Journal of Educational Technology*, 36(3), 69–88. https://doi.org/10.14742/ajet.5583

Manarin, K., Adams, C., Fendler, R., Marsh, H., Pohl, E., Porath, S., & Thomas, A. (2021). Examining the focus of SoTL literature—Teaching and learning? *Teaching & Learning Inquiry*, 9(1), 349–364. https://doi.org/https://doi.org/10.20343/teachlearninqu.9.1.23

Merriam, S. B., & Tisdell, E. J. (2016). *Qualitative research: A guide to design and implementation* (4th ed.). Jossey-Bass.

Miller-Young, J. (forthcoming 2025). Research paradigms and methodologies for SoTL. In Hays, L., McCollum, B., & Miller-Young, J. (Eds.), *Educational technology and the scholarship of teaching and learning: Asking questions about our practices*. Thompson Rivers University.

Morgan, A., Sibson, R., & Jackson, D. (2022). Digital demand and digital deficit: Conceptualising digital literacy and gauging proficiency among higher education students. *Journal of Higher Education Policy and Management*, 44(3), 258–275. https://doi.org/10.1080/1360080X.2022.2030275

Nowell, L., Norris, J., White, D., & Moules, N. (2017). Thematic analysis: Striving to meet the trustworthiness criteria. *International Journal of Qualitative Methods*, 16(1). https://doi.org/10.1177/1609406917733847

Oliver, B., & Jorre de St Jorre, T. (2018). Graduate attributes for 2020 and beyond: Recommendations for Australian higher education providers. *Higher Education Research and Development*, 37(4), 821–836. https://doi.org/10.1080/07294360.2018.1446415

Oskoz, A. & Elola, I. (2020). *Digital L2 writing literacies: Directions for classroom practice*. Equinox Publishing Ltd.

Schrum, K. (2021). Enhancing digital literacy through scholarly digital storytelling. In Hays, L. & Kammer, J. (eds). *Integrating digital literacy in the disciplines* (pp. 42–55). Stylus Publishing.

Schrum, K. (2022). Developing student capacity to produce digital scholarship in the humanities. *Arts and Humanities in Higher Education*, 21(2), 158–175. https://doi.org/10.1177/14740222211045246

Schrum, K. (2023). "Expanding our pedagogical imagination": Faculty experiences with technology-enhanced assessment across disciplines. *International Journal for the Scholarship of Teaching and Learning*, 17(1), Article 16. https://doi.org/10.20429/ijsotl.2023.17116

Schrum, K., & Bogdewiecz, S. (2022). Cultivating research skills through scholarly digital storytelling. *Higher Education Research & Development*, 41(7), 2382–2394. https://doi.org/10.1080/07294360.2021.2010667

Schrum, K., Majury, N., & Simonelli, A. L. (2021). Authentic learning across disciplines and borders with scholarly digital storytelling. *Teaching and Learning Inquiry*, 9(2). https://doi.org/10.20343/teachlearninqu.9.2.8

Schrum, K., Majury, N., Simonelli, A. L., & Bogdewiecz, S. (2022). Audience matters: Multimodal projects across three international case studies. *Teaching & Learning Inquiry*, 10(January). https://doi.org/10.20343/teachlearninqu.10.5

Seraphin, S. B., Grizzell, J. A., Kerr-German, A., Perkins, M. A., Grzanka, P. R., & Hardin, E. E. (2019). A conceptual framework for non-disposable assignments: Inspiring implementation, innovation, and research. *Psychology Learning and Teaching*, 18(1), 84–97. https://doi.org/10.1177/1475725718811711

Singh, J. P. (2014). Development remix: Representing poverty, culture, and agency in the developing world. *International Studies Perspectives*, 15(3), 243–56. https://doi.org/10.1111/insp.12023

Snelson, C. (2018). Video production in content-area pedagogy: A scoping study of the research literature. *Learning, Media, and Technology*, 43(3), 294–306. https://doi.org/10.1080/17439884.2018.1504788

Sweeney, T., West, D., Groessler, A., Haynie, A., Higgs, B., Macaulay, J., Mercer-Mapstone, L., & Yeo, M. (2017). Where's the transformation? Unlocking the potential of technology-enhanced assessment. *Teaching & Learning Inquiry*, 5(1). http://doi.org/10.20343/teachlearninqu.5.1.5

Wooley, E., Yammouni, D., & Rayner, G. (2021). Taking the law into their own hands: Innovative digital video assessment in a law degree. In L. Hays & J. Kammer (Eds.), *Integrating digital literacy in the disciplines* (pp. 219–231). Stylus Publishing.

Wu, J., & Chen, D. T. V. (2020). A systematic review of educational digital storytelling. *Computers and Education*, 147, Article 103786. https://doi.org/10.1016/j.compedu.2019.103786

Yi, Y., Shin, D. & Cimasko, T. (2020). Special issue: Multimodal composing in multilingual learning and teaching contexts. *Journal of Second Language Writing*, 47, Article 100717. https://doi.org/10.1016/j.jslw.2020.100717

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8. Using Phenomenography as a Theoretical Framework for Investigating Student Experience With Edtech

BRETT MCCOLLUM

Introduction

Early on in my SoTL journey, I felt comfortable with quantitative methods that answered research questions in the form of 'what works.' I quickly realized that for all the value that quantitative studies provide, they cannot answer all questions. There are aspects of the human experience, including those within teaching and learning, that might be better understood through qualitative methods. For example, it is not possible to quantify what a learner is doing or thinking when they engage with a learning resource without some degree of interpretation on the part of the researcher. Either the researcher assigns categories a priori based on assumptions of how the learner will interact with the resource, or the researcher generates a coding system to describe their observations. In both cases, the categories or codes represent one or more qualitative variables, and the researcher is using their expert judgement to assign observational data within the parameters of these variables. While statistical methods can be applied to the categorical data (Agresti, 2013), the bias of the researcher is unavoidable. This does not devalue the approach, rather it necessitates disclosure of bias.

Once I overcame my initial opposition to qualitative research, I began experimenting with different styles of research questions. In one study, I investigated 'what is happening' when learners attempt to translate between three-dimensional representations of molecules (McCollum et al., 2016). This involved collecting think-aloud interview data and analyzing it to identify the variation in problem-solving strategies that learners developed. Later, I undertook a study of 'what is possible' when learners are challenged to problem solve live over video chat with a peer in another country (Skagen et al., 2018). It is this latter style of question, alternatively phrased as 'visions of the possible' among the taxonomy of SoTL questions (Hutchings, 2000), that continues to capture my imagination. Arguably, most SoTL projects involving novel educational technology initially involve this type of research question. We must first discover what is possible with educational technology before we can explore the processes involved or the impacts of these new opportunities.

In this chapter, I introduce the reader to phenomenography. Phenomenology can be viewed as a research methodology, or the methods and procedures used to collect and analyze data. However, a more encompassing perspective is that of a theoretical framework, wherein the theory of phenomenography includes specific assumptions and rulesets that determine the parameters of the study from the outset. As a theoretical framework, it shapes the research questions, influences the methodology of the study, and guides the researcher in their choice of conceptual framework for interpreting the data. In particular, phenomenography as a theoretical framework can be used to investigate variations in a learning experience across a population. This framework is particularly appropriate for 'what is happening' and 'what is possible' SoTL research questions and can be used for qualitative or mixed methods studies.

Selecting a Research Paradigm to Study Personal Experience

All learning experiences are personal. Many learning experiences are also social. In 2016, Dr. Layne Morsch of the University of Illinois – Springfield and I decided to try leveraging information and communication technologies for a novel learning experience in chemistry. Our plan was to pair our students, one Canadian and one American per group, and have them meet over video chat six times during a semester to collaborate on organic chemistry homework. We designed the experience to include personal and social components. We reflected on our two contexts: the ubiquity among our student populations of mobile personal computing devices (phones, tablets, laptops) equipped with microphones and cameras. Yet we did not know how it was going to be received by our learners. We were not sure what would work as intended, what would go smoother than we anticipated, and what would go horribly wrong.

As described in **Chapter 2**, phenomenography aligns with the paradigm category that involves empirical research that aims to build theory and where the researcher values objectivity and strives to minimize researcher influence. Working within this paradigm, my colleague and I sought to understand under what conditions our innovative approach to teaching organic chemistry was possible. We also had to actively discuss and document our positionality relative to the experience we were studying. We were experts in the field of chemistry. Our students were novices. We had significant experience using synchronous video communication technologies for professional work. While there was near unity for the fraction of students in our classes that had used video chat before, almost none had used video chat for any purpose other than socializing with friends or visiting with a relative. Communicating over video chat for academic or professional purposes, particularly with a stranger, was outside the realm of comfort for our students.

Tracking student performance on the exams, relative to other sections or semesters, could give us metrics on the impact of this learning intervention. We could collect observational data from the student pairs by having them submit video recordings of their meetings. However, we were most interested in understanding if it was possible to use information and communication technology to connect learners across an international border for synchronous communication. By possible, I mean was it feasible or realistic to expect a group of second year university students to contact a stranger from another country, organize times across different time zones to meet over video chat, complete individualized preparatory work, and then engage with their assigned international partner respectfully and professionally? Thus, we began asking questions such as the following:

- What barriers would students tell us they had experienced during their international online collaborative learning?
- How would students describe the experience?
- What skills would students report developing as a result of using this communication technology for academic purposes?

These questions emphasize the learner's experience from their own perspective. How significant we, as the researchers, felt a barrier was for a student, or even whether we considered something within the experience as a barrier rather than a benefit, was not the focus of our work. Our goal was to understand research participants' experiences and minimize our subjectivity when interpreting participants' descriptions of the experience. Thus, we needed a framework for our SoTL study that would provide us with a 'ruleset' to address our positionality, manage our bias, and honour the contributions of our participants by sharing their voices with minimal interpretative filtering.

Phenomenography as a Research Framework

Phenomenography is a qualitative research framework used to identify and categorize the variations in how people experience a phenomenon (Marton, 1981). Implied within this brief description are a few assumptions:

1. The objective of the research is to inductively generate a hypothesis/model/theory, not test the veracity of a hypothesis (Glaser & Strauss, 1967).
2. People can experience, conceptualize, understand, perceive, and apprehend phenomena in and of the world in distinctly different ways (Marton, 1994).
3. The data collection method will generate qualitative data that can be analyzed to identify the variations in experience.
4. The number of distinct ways that people can experience a phenomenon is finite.
5. Sampling a large enough number of participants from a population can permit a researcher to observe the complete set of variations for that population.
6. The conclusions of the research report how participants themselves describe their relationship to the phenomenon (Pang, 2003).
7. The phenomenon under study is not being considered in the absence of the population under study (Bowden, 2000; Limberg, 2000); in this sense, the conjoined subject-object relationship is the experience being investigated (Yates et al., 2012).
8. The researcher is examining participants' descriptions of the experience, not the experience itself (Säljö, 1997).

Given that the ways an experience may be described can vary from population to population based on their prior experiences and cultural aspects of discourse, description of context is important in phenomenographic research. Furthermore, the context of the researcher, their positionality relative to the subject-object relationship, should be disclosed (Sandbergh, 1997). Appropriate experimental controls and checks on researcher interpretations should be structured within the study's design.

Similar to research within a positivist paradigm, reproducibility, replicability, and reliability are important in phenomenographic studies. Reproducibility means that if another researcher is working with the same data set and methods, even with the impacts of researcher positionality, they should be able to reproduce the findings. Replicability means that if the study was repeated, the same results would be obtained. In phenomenography, this would necessitate repeating the study on the same population, given that how individuals—and by way of extension, a population—experience a phenomenon is influenced by context. However, how humans experience the world around them can also be time-dependent, and thus, replicability cannot necessarily be assumed or expected for phenomenographic studies. In the context of our study, how students experienced using video chat for learning changed as campus WiFi improved. Descriptions of the experience changed again during the COVID-19 pandemic. This does not imply that the results from the original data analysis were not valid, or that they no longer provide value. Rather, it is the responsibility of scholars and practitioners to reflect on the relationship between context and replicability when reading phenomenographic studies. The third 'R,' reliability, means that our findings are appropriately robust to withstand scrutiny by scholars using alternative methods. This is not the same as suggesting that your results are 'true,' which is fundamentally an epistemological question. Triangulating phenomenographic results with analysis of other qualitative or quantitative data, such as student performance data, can increase your trust that your conclusions are reliable.

The result of a phenomenographic study is a well-defined set of categories that attempts to span the outcome space of possible variations in a subject-object relationship. While the observed outcome space may not be identical to the true outcome space for the population depending on the sampling method (Åkerlind et al., 2005), data collection until saturation is achieved is one approach that can improve the reliability of the set of categories (Trigwell, 1994, 2000).

The set of categories has as few elements as is feasible for describing the critical variation in experience and meets the following criteria for the set (Bruce, 1997; Marton & Booth, 1997):

- Each element within the set must describe a distinctly different aspect of the experience (it must be qualitatively different from the other categories).
- Each element within the set should logically be related to each other element.
- The complete set of elements describes the observed critical variation.

Finally, the structure of the outcome space can present as three possible types based on the logical relationship between the elements. The outcome space is either hierarchical, developmental, or participant past-experience dependent (Laurillard, 1993).

Applying a phenomenographic framework to the study of online collaborative learning involved selecting a research question situated around the learner's experience with the phenomenon, aligning that research question with an appropriate data collection method, and using inductive data analysis methods.

Methods

Interviews and Focus Groups

Within a phenomenographic framework, in order to form a model of your research participants' experiences with respect to a phenomenon, you must first collect descriptions of the experience from your participants. Generally, this can take two forms: one-on-one interviews or focus groups (Gill et al., 2008). The choice of one method over the other depends on the objective of the data collection.

Interviews with individual participants can be structured, semi-structured, or unstructured (Yeo et al. 2023). For semi-structured interviews, key questions are selected by the researcher in advance with the intention of pursuing follow-up lines of questioning dependent on the responses of the participant. This permits the researcher to obtain information about the experience that participants deem relevant beyond the researcher's original parameters of interest. While this method is more time intensive than a research questionnaire or survey, the dynamic interaction between the researcher and the participant in an interview yields significantly more insight into the experience of the participant. The resulting increased depth of qualitative data is valuable for enhancing the reliability of the outcome space.

Focus groups are an organized discussion with a group of participants (Krueger & Casey, 2009; Gibbs, 2012). A key distinction of focus groups relative to individual interviews is the interaction between participants. Thus, the researcher must be prepared to act as a facilitator of the conversation, creating opportunities and extending invitations for all participants to contribute to the discussion. Depending on the phenomenon, the individuals within a group, and the skill of the interviewer, focus groups can generate consensus or reveal diverging perspectives of an experience. For a phenomenographic study, which seeks to identify the variations in how people experience a phenomenon, the researcher will employ probing questions that seek to expose differences in opinion within the group. Furthermore, the researcher should express appreciation for, and validity of, these varied descriptions of the experience. This helps participants discuss their feelings and opinions openly and minimizes the potential impacts of groupthink. Yet it must be acknowledged that the researcher cannot predict how the group dynamics will play out. Proper documentation of

the conversation by audio recording and of the observed context of each focus group by way of field notes, will aid the researcher during data analysis (Krueger & Casey, 2001; Phillippi & Lauderdale, 2018).

As a research method, focus groups are not suitable for hypothesis-testing studies (Vaughn et al., 1996). This is not a problem for work framed by phenomenography due to its hypothesis-generating nature. Focus groups are effective for quickly gathering information on how participants are experiencing change. Members of the group may provide complimentary information that fills in the gaps from the description of a single participant. On the other hand, focus groups may discourage certain population members from fully contributing or participating at all, and findings may not generate the same depth of insight as one-on-one interviews (Halcomb et al., 2007). Hence, the choice of sampling method should be reported, and attainment of data saturation is important for a phenomenographic study.

For our study of student experiences with international online collaborative learning (OCL), we chose to use focus groups. Our purpose in selecting focus groups over interviews was to have participants hear a range of OCL pair dynamics and discuss how each other's experiences compared and contrasted to their own. To avoid a conflict of interest in our dual roles as instructors and researchers, and to minimize its potential impacts on group discussions, we chose to have senior undergraduate student researchers facilitate the focus groups. Having these near-peers managing all interactions with participants demonstrably increased the comfort of our students during the focus groups, yielding descriptions of the experience that may not have been reported if a faculty member had facilitated the groups.

At the beginning of each focus group, the facilitator described the obligation of all attendees to maintain the anonymity of participants, the purpose of the data collection, and the potential impact of the results to inform future pedagogical decisions. Throughout the focus groups, participants were asked how their experience compared to a previous speaker. When new issues would emerge during the discussion, the facilitator would ask additional questions, demonstrating interest, to obtain additional detail.

The initial foci for our SoTL study on learning experiences during OCL were barriers and benefits of the novel approach. This included barriers/benefits involving the educational technology (hardware, software, WiFi connectivity, etc.) and the social component of working with an international partner. During our focus groups, the topics of professionalism, professional skills, and professional identity emerged. Our facilitators skillfully probed for more information when participants raised these unanticipated topics. Participants described navigating technological barriers with support from their partner and situated their comments within language related to professional skills. They reported how an early semester lack of professionalism from their partner, or from themselves, harmed the trust between partners. Further questioning from the facilitator revealed that across the six assignments, student pairs were broadly successful in addressing differences in meeting preparation, which resulted in strengthening the relationship between partners. The course instructors, Dr. Morsch and myself, separately observed complementary evidence of this bonding between partners when we suggested to our classes that the partners would be reassigned after the third assignment to provide an opportunity to meet another international peer. In both classrooms, chaos erupted. One particularly vocal student jumped out of their seat and shouted, "You can't take my Canadian away from me!"

In the focus groups, we observed that as participants grew comfortable with the facilitator, each other, and the structure of the focus group, they were more proactive in emphasizing the similarities and differences in their experiences and provided more supporting examples from their OCL pair interactions. After several focus groups, the facilitators began meeting regularly to compare field notes and assess if new descriptions of the phenomenon critically varied from previous focus groups. This provided an early estimation of data saturation and indicated when we were ready to begin data analysis.

Qualitative Coding

Focus group audio recordings were transcribed, and then we, as the researchers, read the transcripts several times to familiarize ourselves with the data. Next, a subset of transcripts were line-by-line inductively coded to generate an initial set of codes (Thomas, 2006). This coding process was carried out by members of the research team independently, and then the team met to discuss the emergent codes. The choices of names for codes, their meanings, and how they should be applied to the transcripts was refined through collegial debate. This process of coding and refining the codes was repeated for several iterations before additional transcripts were added to the coding process. Additional iterations of code refinement then followed until saturation was achieved, meaning that no new codes emerged, and the researchers reached a consensus on code names, meanings, and how the codes should be applied to passages within the transcripts. Although we describe the codes as 'emerging' from the data, it is important for researchers to again acknowledge their positionality and how it influences their observation of the codes through active choices (Fine, 2002).

The remaining transcripts were then coded by two or more team members using the established coding system. Based on our initial reading of the transcripts to familiarize ourselves with the data, we were confident that no additional codes would be required, and thus, a deductive coding approach was appropriate at this stage.

Code Clustering and Thematic Analysis

With codes established, the research team began to cluster the codes into themes. This process, known as thematic analysis (Braun & Clarke, 2006; Saldaña, 2009), aims to reduce the number of elements (categories) within the phenomenographic outcome space to its minimal critical set. Thematically organizing the individual codes resulted in a reduction from over a dozen codes to only three themes that spanned the entire outcome space. Thus, a benefit of this analysis approach is to simplify the narrative of your findings for dissemination. Having an outcome space of three to five themes permits your audience to more effectively understand the findings of your SoTL study. In our study of how students experience OCL with an international peer in organic chemistry, we obtained four themes: impact, barriers, resources, and collaborative learning approaches.

Communicating Our Results

The richness of our data was prohibitive for publishing all of the results in a single manuscript. Thus, we prepared separate manuscripts addressing the themes of impact (Skagen et al., 2018) and barriers (McCollum et al., 2019). For example, within the theme of barriers for OCL with an international partner, we identified three codes: (1) content and pedagogy, (2) social interactions, and (3) technology. In that manuscript, each code was presented as a sub-header. The observed variation in ways that our participants experienced the phenomenon relative to that code was described under that sub-header. Quotes from our focus groups were provided to the reader with appropriate framing of context and importance. Our findings were situated within existing literature to more fully explain our observations and solidify our conclusions with established theory.

Including Scholarly Details on Abysmal Failures

As a scholar of teaching and learning, I strive to provide sufficient detail in publications to permit other scholars and practitioners to replicate my teaching initiative within their own courses. Beyond research findings, this includes descriptions of what worked as intended. It also involves the exploration of issues that emerged, resistance among stakeholders, and what can best be described as abysmal failures.

For example, the SoTL study investigating barriers for OCL found several technological barriers in the Fall 2016 semester that necessitated changes in design before the project could be repeated in a future semester (McCollum et al., 2019). Campus WiFi was so unreliable that one participant stated, "we learned not to trust the WiFi," and another said, "we would just have to mime the whole time" (p. 12). As a result, the technology became a distraction rather than affording new opportunities for learning. While our students were exceptionally patient with the situation, I did not consider the status quo to be sustainable. Fortunately, when I made inquiries, I learned that my university was in the midst of a campus-wide WiFi upgrade, which was temporarily decreasing the reliability of the network but would ultimately double WiFi capacity once the upgrades were complete. Based on the experience described by our participants, I would not recommend the use of OCL unless all learners had adequate access to a reliable WiFi network.

Another example of an abysmal failure from the same study was identified in terms of learning gains from one segment of our participants. Quantitative data on student performance revealed measurable gains on standard exam questions for the Canadian students, relative to previous semesters, but no comparable improvement for the American learners. Initially, we were unable to explain the presence of this variation across the two populations. The answer came from our phenomenographic study. In the focus groups, participants described how the American students were assigned the responsibility of recording the video chat meetings and submitting them to their instructor. Training had been provided to the American students by their university's I.T. department on how to use the recording software, but technical issues still arose during student-pair meetings. In contrast, the Canadian students were not required to record the meetings since that task was already being completed by their partner. This differential in responsibilities did not markedly change the experience for all learners, but it did for some American students. As one learner stated, "I didn't really feel like I learned that much because there was so much technology issues that I was freaking out about that the whole time" (p. 13). The context of cognitive load for the American partners was different enough from their Canadian counterparts that the change in exam performance by the average American student was not statistically significant, despite our observation of improved learning for the Canadian students. Given that one of the objectives of our teaching innovation was to improve student learning, we considered this result a failure that required a redesign of the experience. The next time we deployed the OCL assignments, we removed the requirement for recording the video chat meetings. A description of the iterative redesign of the OCL experience in collaboration with students was ultimately reported as a case study of Students as Partners (McCollum et al., 2019); our work reflecting the cyclic process of scholarly teaching is shown in **Figure 4.1** of **Chapter 4**.

Conclusion

Qualitative research frameworks, such as phenomenography, provide value both in terms of a theoretical underpinning (Ravitch & Riggan, 2016) for the work and as a standardized set of rules that the SoTL scholar agrees to abide by. Similar to using standard equipment in a chemistry lab or a validated survey tool in social sciences work, the use of a research framework allows your audience to quickly understand the strengths and limitations of your study. Similar to methodological or instrumental approaches in other forms of research, increased use of a particular framework by a researcher can enhance their expertise with that framework and improve their scholarship. Your choice

of framework guides the way you frame your research question, how you investigate it, and what you can report at the end of your study. With its emphasis on the conjoined subject-object relationship, phenomenography is exceptionally useful for SoTL inquiry on how learners experience educational technology or how educators experience teaching with educational technology.

References

Agresti, A. (2013). *Categorical data analysis* (3rd ed.). John Wiley & Sons.

Bowden, J. A. (2000). The nature of phenomenographic research. In J. A. Bowden, & E. Walsh (Eds.), *Phenomenography* (pp. 1–18). RMIT University Press

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bruce, C. (1997). *The seven faces of information literacy*. Auslib Press

Fine, M. (2002). *Disruptive voices: The possibilities for feminist research*. University of Michigan Press.

Gibbs, A. (2012). Focus groups and group interviews. In J. Arthur, M. Waring, R. Coe, & L. V. Hedge (Eds.), *Research methods and methodologies in education* (pp. 186–192). Sage.

Gill, P., Stewart, K., Treasure, E., & Chadwick, B. (2008). Methods of data collection in qualitative research: Interviews and focus groups. *British Dental Journal*, 204, 291-295. https://doi.org/10.1038/bdj.2008.192

Glaser, B. G., & Strauss, A. L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Aldine.

Halcomb, E. J., Gholizadeh, L., Phillips, J., & Davidson, P. M. (2007). Literature review: Consideration in undertaking focus group research with culturally and linguistically diverse groups. *Journal of Clinical Nursing*, 16(6), 1000–1011. https://doi.org/10.1111/j.1365-2702.2006.01760.x

Hutchings, P. (2000). *Opening lines: Approaches to the scholarship of teaching and learning*. Carnegie Foundation for the Advancement of Teaching.

Krueger, R. A., & Casey, M. A. (2001). Designing and conducting focus group interviews. *Social Development Papers: Social Analysis Selected Tools and Techniques*, 36, 4–23.

Krueger, R., & Casey, M. (2009). *Focus groups: A practical guide for applied research* (4th ed.). Sage.

Laurillard, D. (1993). *Rethinking university teaching: A framework for the effective use of educational technology*. Routledge.

Limberg, L. (2000). Phenomenography: A relational approach to research on information needs, seeking and use. *The New Review of Information Behaviour Research*, 1(December), 51–67.

Marton, F. (1981). Phenomenography — Describing conceptions of the world around us. Instructional Science, 10, 177–200. https://doi.org/10.1007/BF00132516

Marton, F. (1994). Phenomenography. In T. Husen, & T. N. Postlethwaite (Eds.), *The international encyclopedia of education* (2nd ed., Vol. 8, pp. 4424–4429). Pergamon.

Marton, F., & Booth, S. (1997). *Learning and awareness*. Lawrence Erlbaum Associates.

McCollum, B., Morsch, L., Pinder, C., Ripley, I., Skagen, D., & Wentzel, M. (2019). Multi-dimensional trust between partners for international online collaborative learning in the third space. *International Journal for Students as Partners*, 3(1), 50–59. https://doi.org/10.15173/ijsap.v3i1.3730

McCollum, B., Morsch, L., Shokoples, B., & Skagen, D. (2019). Overcoming barriers for implementing international online collaborative assignments in chemistry. *The Canadian Journal for the Scholarship of Teaching and Learning*, 10(1). https://doi.org/10.5206/cjsotl-rcacea.2019.1.8004

McCollum, B., Sepulveda, A., & Moreno, Y. (2016). Representational technologies and learner problem-solving strategies in chemistry. *Teaching & Learning Inquiry*, 4(2), 1–14. https://doi.org/10.20343/teachlearninqu.4.2.10

Pang, M. F. (2003) Two faces of variation: On continuity in the phenomenographic movement. *Scandinavian Journal of Educational Research*, 47(2) 145–156. https://doi.org/10.1080/00313830308612

Phillippi, J., & Lauderdale, J. (2018). A guide to field notes for qualitative research: Context and conversation. *Qualitative Health Research*, 28(3), 381–388. https://doi.org/10.1177/1049732317697102

Ravitch, S. M., & Riggan, J. M. (2016). *Reason and rigor: How conceptual frameworks guide research*. Sage.

Saldaña, J. (2009). *The coding manual for qualitative researchers*. Sage.

Säljö, R. (1997). Talk as data and practice—A critical look at phenomenographic inquiry and the appeal to experience. *Higher Education Research & Development*, 16(2), 173–190. https://doi.org/10.1080/0729436970160205

Sandbergh, J. (1997). Are phenomenographic results reliable? *Higher Education Research & Development*, 16(2), 203–212. https://doi.org/10.1080/0729436970160207

Skagen, D., McCollum, B., Morsch, L., & Shokoples, B. (2018). Developing communication confidence and professional identity in chemistry through international online collaborative learning. *Chemistry Education Research and Practice*, 19, 567–582. https://doi.org/10.1039/C7RP00220C

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation*, 27(2), 237–246. https://doi.org/10.1177/1098214005283748

Trigwell, K. (1994). The first stage of a phenomenographic study of phenomenography. In J. A. Bowden, & E. Walsh (Eds.), *Phenomenographic research: Variations in method* (pp. 56–72). RMIT University Press.

Trigwell, K. (2000). A phenomenographic interview on phenomenography. In J. A. Bowden, & E. Walsh (Eds.), *Phenomenography* (pp. 62–82). RMIT University Press.

Vaughn, S., Schumm, J., and Sinagub, J. (1996). *Focus group interviews in education and psychology*. Sage.

Yates, C., Partridge, H., & Bruce, C. (2012). Exploring information experiences through phenomenography. *Library and Information Research*, 36(112), 96–119. https://doi.org/10.29173/lirg496

Yeo, M., Miller-Young, J., & Manarin, K. (2023). *SoTL research methodologies: A guide to conceptualizing and conducting the Scholarship of Teaching and Learning*. Routledge. https://doi.org/10.4324/9781003447054

PART III

SECTION III: RESEARCH AND SCHOLARLY REFLECTIONS ON EDUCATIONAL TECHNOLOGY

This section consists of six chapters and serves as a collection of case studies and essays about SoTL projects examining teaching and/or learning with educational technology. These case studies provide readers with opportunities to reflect on how a variety of philosophical lenses, research questions, and methodologies find space within the scholarship of teaching and learning. The authors go beyond reporting scholarly results, offering personal reflection on their project design choices that maintained the focus on teaching and learning for their studies of educational technology.

In **Chapter 9: Learning in Digital Spaces: Technology's Impact on Teacher Learning and Practice**, Anna Bartosik demonstrates how digital ethnography can be used to investigate self-directed professional growth of educators in open digital spaces. She grounds her work in Posthuman theory and Actor-network theory. Seeking to understand how learning and networking is understood by participants in a digital space relative to in-person environments, she finds that learner agency cannot be separated or demarcated from the technology.

In **Chapter 10: Generative SoTL: Exploring AI in Inquiry**, Elisa Baniassad explores the ways AI intersects with SoTL, from enabling research methodologies to reimagining educational roles and responsibilities and argues for proactive engagement with AI.

In **Chapter 11: Challenging Assumptions About HyFlex Teaching with Students as Partners**, Zoya Adeel, Stefan M. Mladjenovic, Kate Brown and Katie Moisse address the timely topic of hybrid-flexible learning environments in **Chapter 10**. Specifically, they address changes in students' engagement and perspectives pre and post-COVID.

In **Chapter 12: Scholarly Design of Interactive Instructional Videos for Online and Flipped-Class Learning**, Riley J. Petillion and W. Stephen McNeil offers retrospective reflection on the motivations, design, deployment, assessment, and revision of interactive learning resources in a large flipped introductory course. This chapter contextualizes their study with theory both relevant across the academy and more specific to their discipline, and describe how their innovation was iteratively adapted in response to student feedback and environmental factors.

In **Chapter 13: Using an Interactive Online Game Platform for Teaching and Learning**, Rosmawati, Budianto Tandianus, and Hock Soon Seah examine the use of augmented and virtual reality for learning activities with the Community of Inquiry framework. This chapter shares how certain limitations of in-person teaching can be alleviated in a virtual space. Furthermore, the authors propose practical strategies for improving the implementation of the technology to better focus student attention to the learning of course content rather than familiarization with the technology's user interface.

Finally, in **Chapter 14: Statistically Significant: Reflecting on the use of Educational Technology in Online Introductory Statistics Courses**, Rachael Lewitzky explores how pedagogy, content, and technology can be woven together in online spaces. Using content analysis with course materials and the TPACK framework (Mishra & Koehler, 2006) to deductively code semi-structured interviews of course instructors, Lewitzky uses three themes to organize the relationships between the course and the technology used to teach it.

By applying varied theoretical frameworks, methodologies, and reflective approaches, the authors in this section demonstrate how technology can shape and be shaped by pedagogical practices. They provide valuable insights

into the complexities of integrating technology in ways that enhance teaching and learning. Together, they encourage readers to critically engage with both the opportunities and challenges of educational technology in diverse learning environments.

References

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teachers' knowledge. *Teachers College Record*, 108 (6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

9. Learning in Digital Spaces: Technology's Impact on Teacher Learning and Practice

ANNA BARTOSIK

Introduction

The rapid advancement of technology has significantly impacted the way we learn and acquire knowledge. With the emergence of digital technologies, learning has been revolutionized, allowing for new and innovative forms of education. In recent years, scholars have increasingly turned their attention to understanding the implications of technology in learning and teaching. This chapter explores the role of posthuman theory and actor-network theory in undergirding teachers' learning with technology, specifically in open digital spaces, and how digital ethnography might be used to study student learning. Posthuman theory acknowledges the entanglement of humans and technology, challenging traditional notions of the human as a separate and autonomous entity, whereas actor-network theory helps conceptualize the relations and connections between the different actors within a network. By examining the interplay between technology and its entanglement with human actants, this chapter contributes to a more comprehensive and nuanced understanding of the complex and evolving relationship between technology and learning.

Self-Directed Professional Development Among Educators

There has always been a small and steady stream of educators who seek out learning outside their work environments as they cannot find the support they need within their places of employment; these digital learning contexts encourage teachers to negotiate meaning and concepts across different teaching contexts (Wenger-Trayner et al., 2015) beyond their workplace and bring back this new understanding to their local work communities. By taking charge of their learning, educators can identify their professional needs, set personal goals, and select the most appropriate resources and activities to meet those needs.

Self-directed professional development (PD) is particularly important in today's rapidly changing educational landscape, where teachers in higher education must be able to adapt to new technologies, teaching methods, and curriculum standards. Many institutions cannot keep up with demands for learning on topics, most recently seen with large language models (LLMs)[1] such as Open AI's ChatGPT and other artificial intelligence tools. As such, this chapter focuses on the results of the author's doctoral research study, stemming from their own interest in learning online, and how teachers engage in self-directed professional growth, the importance of networks, and the role technology plays, and can potentially play, in learning and learning about learning. For the context of this study, teacher learning was conceptualized as learning skills, cognitive processes, reflective practice, and personal development (Richards & Farrell, 2005).

1. A large language model (LLM) is an algorithm which can both produce and convert the written word.

Study Design

Motivation

My research interest in examining teachers guiding their professional learning in digital spaces materialised because educational technology changed my own approach to teaching and learning as a mid-career teacher. This was challenging since I did not have an effective space to discuss my interests about educational technology over 10 years ago within the English language teaching (ELT) community. I noticed that many educators perceived technology as a tool used for learning, with human agency intact over its serviceability. When I started learning about educational technology, I found most of my learning took place online: first, from blogs; then, from the teacher-learning community on Twitter[2]. I appreciated the collaborative inquiry aspect of learning to teach with technology from educational Twitter chats, which I could not replicate in face-to-face settings, and this piqued my scholarly interest in learning more about teachers' learning: I wanted to examine whether there was something unique about teachers learning online and learning through technology that could not be duplicated in face-to-face interactions, but I was initially challenged to find a space where I could freely observe learning taking place without construing the environment for research purposes.

Research and Data Collection

The research this chapter draws from is part of a doctoral dissertation observing Twitter-based discussions among two English language teacher (ELT) Twitter chats, spanning a time frame of three months from autumn 2020 to early 2021. The study was a mixed-method netnography using descriptive statistics, social network analysis[3], discourse analysis, and semi-structured interviews. By focusing on interactions and relationships between actors and technology, this fits best within a critical realist paradigm (**Chapter 2**). The research objectives aimed to uncover the way professional development occurs on Twitter, the distinguishing features between online Twitter chats and conventional face-to-face professional development prospects, and whether language teachers' engagement on Twitter shapes their interests, methodologies, and pedagogical approaches.

Before I settled on netnography, I had examined phenomenology, ethnography, and narrative case studies as methods to explore my research questions. However, the digital space where I intended to conduct my research, then called Twitter, featured unique online characteristics which were important to consider within the methodology of the study. Netnography is a type of ethnographic research conducted online, where researchers analyse the interactions and behaviours of individuals within specific communities. It involves a combination of qualitative and quantitative research methods, which can include participant observation, interviews, surveys, and content analysis. Researchers typically observe and record online discussions, track user behaviours, and analyse the content of online postings to gain insights into the culture and norms of the online community being studied. Netnography provides a unique opportunity to study the behaviour of communities online, which can be challenging to observe in real-world settings.

The concept of conducting research on Twitter was built on two considerations: finding an open space where I

2. The social media platform, now known as X, was called Twitter at the time of the study.
3. Social network analysis is a way of measuring interactions among topics, people, and the ideas they are sharing as well as the influence which people have (Alexanyan et al., 2015).

could observe conversations taking place that were not for research purposes and having access to, and knowledge of, a platform. The Twitter platform allows individuals to create their own connections without the obligation of reciprocity and the data is publicly accessible. Because of the open access to Twitter and Twitter's application programming interface (API), it was possible to observe chats taking place without requesting permission from closed groups or moderators; at the time of the study, it was also possible to collect Twitter data freely through Twitter's API from the previous seven to 10 days.

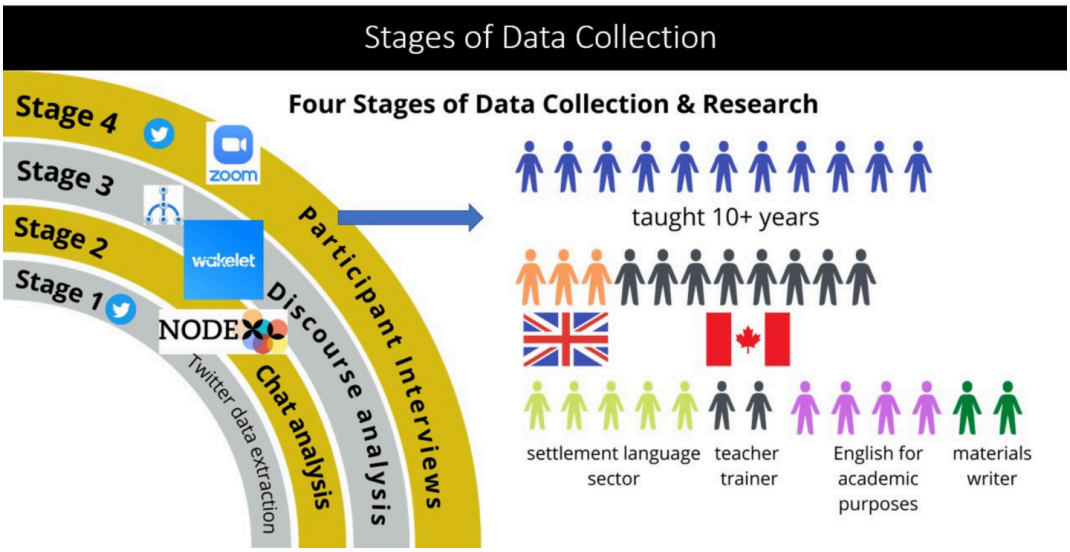

Figure 9.1 *Stages of data collection and interview participants [Long Description available]*

The structure of the four stages of data collection, illustrated in **Figure 9.1**, allowed me to observe the various actants through collecting Twitter data, observing chats, and using social network analysis to help visualize what was taking place on Twitter, with what and with whom. Additionally, digital objects (e.g. the network, hashtags, handles, connections, devices) were "interviewed" through a series of heuristics (Adams & Thompson, 2016) to acknowledge their agency and treat them with the same attention as human participants. In the second stage of data analysis, I examined the ways the Twitter platform itself offered opportunities for interaction as well as prevented exchanges from taking place. In addition to the hashtags and Twitter platform, it was important to examine the structure of Twitter chats and how they are used. At this stage the chat topics and their popularity were examined, which informed the third stage of the study that examined the discourse of the exchanges during the Twitter chats.

It is important to note that Twitter chat participants (n. 363) were not considered research participants until the fourth stage, when specific chat participants, totalling 11 final research participants, were invited to participate in semi-structured interviews. Anyone engaging in the chats who was not an interview participant was anonymised in the visual representation of networked data and was not identified in any way. This detail was clearly outlined in my ethics approval—that individuals who engaged in Twitter chat were not study participants; only the individuals I interviewed were study participants.

Theoretical Framework

Online Learning With a Posthuman Lens

Educational research of human and technological connections, like social media or devices, has a received or embedded view, according to Emke (2019). The first, the received view, is that technology and individuals can be researched as independent of each other; the second, the embedded view, is with humans as the subject of the research, and the technology is used and within the control of the human actant (Emke, 2019). These two views have kept research about social networks, like those on Twitter, to studies involving PLNs[4] and the like (Nicholas et al., 2018; Lupasco, 2017).

Much like Emke, I find these two approaches lacking in research of online spaces involving human participants. Ascribing autonomy to the learner in digital contexts does not consider the agency of the network and the other nonhuman actants which can direct, suppress, or promote learning in digital networks. We need only to misplace our mobile phones and note how often we inadvertently reach for them to check notifications, whether the device has pinged us or not, to understand how reliant we are on technology and the agency it has over our actions. Relying on our mobile phones has even led cognitive scientists to suggest that we use our mobile devices as a physical extension of our cognition, especially in instances which require analytical thinking (Barr et al., 2015).

The emerging literature on posthumanism illustrates that human agency does not extend as far as many think on digital platforms. Posthuman literature (Hayles, 2006; Baraidotti, 2019) can be used to support the understanding of the discourse that takes place online through technology and examines the kind of humans we are becoming. Although posthumanistic approaches are found in various fields (Snaza et al., 2014) in addition to digital humanities (Braidotti, 2019), it is not often found in educational research. This study considers the impact that technology has on learning and does not privilege the learner as autonomous from the digital platform but as a collaborator with technology. As such, a posthuman lens to studying self-directed PD on a social media platform was chosen for this study, as the platforms, technology, devices, language, and access to digital communication networks all play a role in how we communicate and, thus, impact how we learn. However, a posthumanist lens does not account for the behaviour of networks; for this, I turned to actor-network theory.

Learning as Other Than Social Mediation; Networks Enacted

Actor-network theory (ANT) was incorporated into my theoretical framework to help reconceptualize the actants in the network, since the social network analysis tool I used only recognizes Twitter handles and connections between them and I wanted to examine how all actants, both social and material, have agency in the learning process. ANT affords all actants in the network the same agency, whether they are a device, technology, URL, or person; the network is not activated until an actant engages it (Latour, 2005). This can be a person sending out a tweet, the WiFi turning on, a hashtag being used, or a scheduled tweet being posted on Twitter.

Using this theory also directed me to ask:

- If one of the connections is affected, what else can be affected?

4. PLNs exist within or outside of an organization, and can exist independent of an organization, although they can also be organized within or by an organization.

- Will movement or disruptions in the network impact the network negatively?

Through the observation of weak ties (Granovetter, 1973) and how individuals with few ties can disseminate information to a new network, all parts of the network become important and the interaction becomes the focus, not how "people view their activity on Twitter" (Bartosik, 2022, p. 21) as within their control. Learners engaging in PD on Twitter who were, for the most part, lurking may not be initially seen as learning or disseminating knowledge, but through the use of ANT to trace engagement and then through interviews with participants, I was able to trace and appreciate how silence can be measured and understood as learning.

In the fourth stage of data collection, Twitter chat participants were selected based on the social network analysis data: the most influential and active chat participants were invited to an interview, in addition to those who were not very active at all. Some interview participants, who had been invited to be part of the study because the network analysis had identified them as lurkers, were in fact very active and influential in their teaching and learning communities and used what they had learned on Twitter in knowledge dissemination outside of the platform.

Framing Posthumanism and ANT to the Study

Actor-network theory was applied to understand the social-network analysis in the first stage of the study, seen in Figure 9.1. ANT provides a means to identify the actants in the network and their relationships to the other actants as well as identify network changes, but it does not provide clarity about behaviours within the network. The entanglement of the platform and other nonhuman trappings that teachers immerse themselves in on Twitter points to the lack of autonomy the teacher has from the technology as it coexists in learning. As chat and discourse analyses on the Twitter chats were conducted in stages two and three and participant interviews were analysed, the posthuman lens was used to understand how the learning being observed was socially constructed and entangled with the nonhuman elements through how hashtags were used, how well users knew the Twitter platform and understood its framing of their learning, and how users understood how to navigate the platform to personalize their learning. This was an essential stage in data analysis in order to identify how familiarity and knowledge of a digital platform, whether it is educational technology or a social media app, can impact learning. I provide some examples in the next section.

Study Results

A Look at Chat Participant Awareness of the (Socio)Material

In participant interviews, several chat lurkers were quick to indicate that they were not aware of all of Twitter's affordances. However, as it turned out, even Twitter users who were not fully aware of Twitter's capabilities in the study were aware of Twitter's mechanisms and accepted the algorithmic suggestions because they seemed to know what was wanted, as seen in the quote below:

> *It seems like Twitter analytics knows what I get interested in and it keeps showing me stuff that I keep clicking on.*

Others had very sophisticated and accurate impressions of how networks on Twitter worked:

> *I just have a visual of this huge, I don't know, network, some parts like cogs and some parts like a spiderweb and it's like everywhere, right? And there are all these connections…*

Study participants stated that as they became familiar with how the Twitter platform operated, they began to edit the list of people they followed and made deliberate choices to round out their professional development. Even study participants who claimed they were unaware of how the Twitter platform influenced their learning expressed various strategies they used to counteract the agency of the nonhuman actants that influenced their learning, such as capitalizing on the power of hashtags, the "follow" option, and creating lists. However, there were also human actants that influenced how and when learning took place in Twitter chats, such as the chat moderators.

Chat moderators, or those with betweenness centrality[5], play a major role in the continued existence of chat networks because almost all information and conversations in chats move through them. Chat hosts also have agency by deciding the direction of the chat. The chats related to Intersectionality and Race and Queerness in ELT were topics guided by the chat hosts, as confirmed by study participants. One moderator spoke about the agency their followers provide them:

> *Once I got to about 5000 (followers) I started to think: ok, you have a platform now and you need to take responsibility for the things that you say and use that platform change the way ELT works.*

The role of the network, the actants within it, and the human and nonhuman actants all guided the direction of chats in addition to the topics chosen for the English language teacher chats. I mentioned earlier that learning within digital networks encourages movement across disciplines, which was evident in this study as well; teachers were engaging in social justice issues and their chats were influenced by current events taking place. This was evident in the hashtags they used and followed, such as #MeToo, #SustainabilityInELT, and #Intersectionality. These hashtags caught my interest as a researcher because, on the surface, they are not on the topic of English language teaching.

However, the chat moderators, aware of their impact, brought topics that were socially important into the discussions of English language teaching. When the hashtag #ELT is used with #Intersectionality, the two distinct hashtags, used together in one tweet, could provide those interested in either topic the opportunity to interact together if someone searched one or the other hashtag. Their public chat discussions and the learning they took from chats were then applied to their teaching contexts, which interview participants said they did regularly. Therefore, although human actants guided the chat topics because of their philosophy, the use of non-human actants, such as hashtags, guided who might engage with the chat if it piqued interest.

Learning (In)Action?

When asked about their reason for being on Twitter, some of the study participants spoke about looking for a place to "listen" and learn about topics they a) knew very little about; b) were interested in; c) did not have opportunities to learn about in their work contexts, and d) could learn about in a safe and welcoming environment, away from their work contexts. These reasons were evident even among those with more currency in the chats, who were active and encouraged others to engage but, in interviews, revealed that some topics they would not address publicly for fear of reprisals. Some of those "forbidden" topics included opinions about unpopular government initiatives in the Canadian English language teaching landscape, whereas others worried over their personal beliefs related to politics or social justice. One participant agonized over the simple act of clicking "like" on a tweet.

5. Betweenness centrality is one of the ways social network analysis measures popularity in a network graph; it shows how connected someone is within a network. For example, someone with betweenness centrality connects different parts of a network and, if removed, can cause parts, or the whole, of the network to collapse.

> *Should I like this tweet? Because what if my employer sees that? Should I separate my political interests and my just human interests? Should I create another Twitter handle? I'm never sure about that and I kind of gave up on that…I sometimes withhold liking certain tweets when I think it might work against me in the future.*[6]

The silence during some of the very popular chats was not indicative of a lack of participation or people not learning. During the chat on Queerness in ELT, there was a high number of chat participants, demonstrated by the number of likes and retweets. However, there was little engagement beyond this, possibly because identifying with the queer community could result in job losses or even imprisonment in some of the countries participants were from. At the time of the study, privacy setting options on Twitter (X) differed from present settings, and no one on Twitter could not hide their "likes" unless their profile was private, which would not allow them to participate in a public chat. The chat participant avatars were often photos of themselves and their Twitter handles either partially or fully identified their real identities. Other chat participants may have been silent because they were lurking to learn more about Queerness in ELT.

The Material: The Tools, The Hashtag, and The Chats

Retweets as Learning

As much as learning was taking place among the interlocutors in chats, the learning was promoted, aided, or suppressed by various elements in the Twitter machine. For example, the retweet gave Twitter handles agency because, once a tweet is reshared, the results of retweeting are not within the control of the human who shared the tweet in the first place and the shared tweet can be shared to a different network. The power of a simple retweet was recognized by one interview participant as a powerful dissemination tool:

> *If you assume the role of the listener, and I think the sharing is another, just the fact that you listened, I think, and then you may share that with someone else, it's already, you know, dissemination as well. You're already spreading the word as well and sharing, but in a different way. Maybe not your own experience, maybe somebody else's.*

The Agency of Digital Tools: "Language" Use

The hashtag played a large role in various aspects of learning, both boosting and suppressing learning. For participants with more understanding about Twitter and hashtags, the hashtag played several roles in assisting learning. Knowledge about hashtag affordances impacted how well they were used. At the most basic level, they provided newcomers to chats with an "address" to arrive at and observe silently, either during or after a chat; a user could potentially click on a hashtag to join other conversations taking place with other groups and join two disparate groups together. Another more significant use was following hashtags in lieu of following handles to see what was current on a specific topic.

As one participant said so eloquently:

6. At the time of the study, X (Twitter) "likes" were publicly viewable; this is no longer the case.

> *A hashtag is like a pebble that's tossed into a pond because it ripples out and you can follow those paths. I'm mixing my metaphors here. But you know, it can lead you down some interesting paths.*

Hashtags as portals to learning present unique ways for accessing information; exchanges can continue long after a chat has taken place and individuals who were not even present during the chat can trace back and see the whole exchange. These possibilities open thinking about nonhuman, or the material, assemblages in digital spaces and the opportunities they provide to learn at one's pace and at the time of need.

Learning within and on a technology platform can be summed up in these ways:

- Learning can be dependent on familiarity of a digital platform;
- Those with more knowledge of a platform benefit from said knowledge;
- Silence is not an indication of disinterest or not learning;
- Learning in one digital space can be transferred to another space;
- Learner agency is not separate from technology—the learner and the nonhuman trappings are ensnared and trying to demarcate where one ends and the other begins does not acknowledge the agency of technology's influence.

How can these study results be used for studying student learning with technology? I reflect on the possibilities in the next section.

Conclusion

A finding in this study highlighted that those with less knowledge about online platforms are less able to disseminate their knowledge. In stark contrast to lurkers, influencers possess a great deal of social capital (Adam & Roncević, 2003) and use the nonhuman actants in digital learning spaces, like expansive knowledge of a digital platform, to disseminate information or to signal areas of interest or expertise. Those with more social capital in this study also increased their knowledge on subjects outside their areas of expertise.

If we consider an educational setting, similar questions can be asked:

- How well do users know the digital platform they are using?
- Do they understand how it directs or suppresses their learning?
- Has the teacher shared that information with them?
- How do learners understand how to manage the platform they are learning on?

For example, high school students in Ontario, Canada, have been moving to Brightspace, a learning management system from the company D2L. Previously, the majority of teachers had been using Google Classroom. To what extent does the unfamiliarity with a new platform influence the teacher's proficiency of its use and how does the teacher's proficiency, or lack of, influence students' learning?

As stated earlier, an embedded or received view of understanding technology in learning can no longer be the direction educational research takes. The sudden hum among educators and artificial intelligence is heightening this awareness. As Dr. Sarah Elaine Eaton (2023) says:

> *Hybrid writing, co-created by human and artificial intelligence together is becoming prevalent. Soon it will be the norm. Trying to determine where the human ends and where the artificial intelligence begins is pointless and futile.*

We have intelligence agents built into our technology—image suggestions, auto-replies, and predictive

text—that already guide and direct our responses. It is futile to think that a learner is in control of their learning and learning is socially mediated; learning is mediated by actants, both human and nonhuman, and sometimes, we cannot tell them apart. As teachers grapple with the use of generative AI in student work and how the AI tools themselves evolve almost daily, the importance of understanding how technology works and how students learn with this new technology in their hands cannot be ignored.

Finally, while the potential for networks to build social capital has been researched (Endicott, 2011; Fox & Wilson, 2015), this study provided insights into how autonomous choices on digital platforms used for learning are not always possible due to the nonhuman actants such as the platform's restrictions, restrictions for communicating on the platform, and communication tools. These elements can also be examined in digital ethnographic research. The ethical considerations of using technology—such as its environmental impact, like with artificial intelligence; its lack of privacy, as data on specific users can be tracked; and its bias and inequity in the algorithmic results of prompts—all play a role in learning and may affect students' learning negatively.

In the context of education, netnography has the potential to provide valuable insights into student learning by analysing the interactions that take place in online environments. One way that netnography can be used to study student learning is through examining the online discussions and collaborations that occur among students and instructors. This can include analysing the language and discourse used by participants as well as the types of knowledge and skills that are shared and developed through these interactions within a learning management system (LMS), such as which links students click after watching a video or where they pick up after leaving the LMS. Netnographic research could be digital in form and identify which apps students prefer to use, which article students spent a longer time with, or their engagement with other learners on the LMS platform. This type of analysis is different from LMS-offered algorithmic analytics, which focus on learner productivity and performance to identify "at risk" students (Currie, 2022). A narrow understanding of learning does not account for learners remaining silent or leaving the LMS platform for various reasons unrelated to "productive" learning. This perceived approach to learning as being productive can more easily be challenged by researchers as there are now easy tools and add-ins that can complete complex analyses in a short period of time.

One element study participants appreciated about Twitter was the ability to learn without being observed; traditional discussion boards on an LMS name students, which forces learners to publicly demonstrate their learning. Spaces outside the LMS, such as an anonymous Padlet, can provide the same calibre of interaction as a discussion board while also allowing learners to express their learning as it is taking place, without fear of being named or criticized in the process of their learning. Traditional learner analytics on an LMS examine learner engagement—but not the quality of it—with others. The analytical algorithms operate within the parameters the institution has enabled for the LMS and how the teacher uses it, which are digitally imposed restrictions. Learner analytics do not trace how language is used or what a learner clicks next after reading something outside the LMS.

In my study, the definition of learning used included reflective practice (Richards & Farrell, 2005); when interviewing study participants, they were given an opportunity to reflect on what they have learned from using Twitter. Providing learners with an opportunity to explain what influences or impacts their learning and why provides learners with an understanding of autonomy over their learning and gives them an idea of what they can do. No longer is technology being analysed in how it is used, but instead, the shift moves to the learner and how they interact and how their intentions are supported or thwarted by learning. The learner becomes aware of the various opportunities to act. Networked learning is not new but the agency of the nonhuman in the network and its impact on learning is undervalued.

Another way that netnography can be used is by analysing the online resources that students use to support their learning, such as hyperlinks or annotation apps like hypothes.is. This can include examining the types of websites, videos, and other digital materials that students access to learn about specific topics or concepts. In my study discussion, I examined hashtags as portals, language used, and silent learning—how can these apply to student learning

with technology? By leveraging netnographic methods to study student learning, researchers can gain a better understanding of the ways in which technology is shaping education and how educators can effectively support student learning in digital environments.

Conducting digital ethnography can guide educational research in new directions. The digital platform where the netnography takes place is not as important as acknowledging the insights gleaned from examining the agency technology and technology-mediated learning have in both supporting and suppressing learning.

Reflective Questions

- How would you view the use of educational technology in the classroom if you considered it plays an active, not passive, role, in learning?
- How might the theory of posthumanism be applied to students' use of mobile devices for learning in classrooms?
- Can students learn more about a topic when the technology tool they are using to explore knowledge is familiar to them?
- What is the effect that student anonymity in a digital discussion board has on demonstration of learning?

References

Adam, F., & Rončević, B. (2003). Social capital: Recent debates and research trends. *Social Science Information*, 42(2), 155–183. https://doi.org/10.1177/0539018403042002001

Adams, C., & Thompson, T. L. (2016). *Researching a posthuman world: Interviews with digital objects*. Palgrave Pivot London. https://doi.org/10.1057/978-1-137-57162-5

Alexanyan, K., Matei, S. A., & Russell, M. (2015). Socio-computational frameworks, tools and algorithms for supporting transparent authorship in social media knowledge markets. In S. A. Matei, M. G. Russell, & E. Bertino (Eds.), *Transparency in social media: Tools, methods and algorithms for mediating online interactions* (pp. 9–25). Springer International Publishing. https://doi.org/10.1007/978-3-319-18552-1_2

Barr, N., Pennycook, G., Stolz, J. A., & Fugelsand, J. A. (2015). The brain in your pocket: Evidence that smarphones are used to supplant thinking. *Computers in Human Behavior*, 48, 473–380. https://doi.org/10.1016/j.chb.2015.02.029

Bartosik, A. M. (2022). *Learning to stay ahead of the curve: A netnographic analysis of professional development in English language teacher chats on Twitter* [Doctoral dissertation, University of Toronto]. School of Graduate Studies – Theses. https://hdl.handle.net/1807/123569

Braidotti, R. (2019). *Posthuman knowledge*. Polity Press

Currie, S. M. (2022) Universal design in apocalypse time: A short history of accessible teaching exnovation. *The Journal of Multimodal Rhetorics*, 6(1–2), 194–229 http://journalofmultimodalrhetorics.com/files/documents/b7d705e8-31f0-4704-8537-0df7733cdbc4.pdf

Eaton, S. E. (2023, February 25). 6 tenets of postplagiarism: Writing in the age of artificial intelligence. *Learning, Teaching, and Leadership*. https://drsaraheaton.wordpress.com/2023/02/25/6-tenets-of-postplagiarism-writing-in-the-age-of-artificial-intelligence/

Emke, M. (2019). Always in-between: Of rhizomes and assemblages in language teacher education research. In F. Bangou, M. Waterhouse, & D. Fleming (Eds.), *Deterritorializing Language, Teaching, Learning, and Research*. Brill.

Endicott, M. A. (2011). *Peer-mediated teacher change and professional learning in networks: Specialist languages teachers' experience of networking and the production of social capital in a context of curriculum change* [Doctoral dissertation, Griffith University]. Griffith Theses. https://doi.org/10.25904/1912/3564

Granovetter, M. S. (1973). Formalist and relationalist theory in social network analysis. *American Journal of Sociology*, 78(6), 1360–1380. https://doi.org/10.1177/0735275113501998

Fox, A. R., & Wilson, E. G. (2015). Networking and the development of professionals: Beginning teachers building social capital. *Teaching and Teacher Education*, 47, 93–107. https://doi.org/10.1016/j.tate.2014.12.004

Hayles, N. K. (2006). Unfinished work: From cyborg to cognisphere. *Theory, Culture & Society*, *23*(7–8), 159–166. https://doi.org/10.1177/0263276406069229

Latour, B. (2005). *Reassembling the social: An introduction to actor-network-theory*. Oxford University Press.

Lupasco, S. (2017). *Professional learning and networking stories of Canadian TESL practitioners engaged in #LINCchat* [Master's thesis, University of Manchester/British Council]. https://www.teachingenglish.org.uk/sites/teacheng/files/mda2017_university_of_manchester_svetlana_lupasco.pdf

Nicholas, B., Avram, A., Chow, J., & Lupasco, S. (2018). Building a community of connected ELT professionals on Twitter. *TESL Canada Journal*, 35(2), 166–178. https://doi.org/10.18806/tesl.v35i2.1296

Richards, J. C., & Farrell, T. S. C. (2005). The nature of teacher education. In *Professional development for language teachers: Strategies for teaching learning* (pp. 1–22). Cambridge University Press. https://doi.org/10.1017/cbo9780511667237.003

Snaza, N., Appelbaum, P., Bayne, S., Carlson, D., Morris, M., Rotas, N., Sandlin, J., Wallin, J., & Weaver, J. (2014). Toward a posthumanist education. *Journal of Curriculum Theorizing*, 30(2), 39–55. https://doi.org/10.63997/jct.v30i2.501

Wenger-Trayner, E., Fenton-O'Creevy, M., Hutchinson, S., Kubiak, C., & Wenger-Trayner, B. (2015). *Learning in landscapes of practice*. Routledge.

Media Attributions

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Long Descriptions

Figure 9.1 Long Description: The four stages of data collection and research:

- Stage 1: Twitter data extraction

- Stage 2: Chat analysis
- Stage 3: Discourse analysis
- Stage 4: Participant interviews

Final interview participant demographics are:

- All have taught for more than 10 years
- Nationality:
    - 3 from the UK
    - 8 are from Canada
- Occupation:
    - 5 are in the settlement language sector
    - 2 are teacher trainers
    - 4 are in English language teaching for academic purposes
    - 2 are materials writers

[Return to Figure 9.1]

10. Generative SoTL: Exploring AI in Inquiry

ELISA BANIASSAD

Introduction

The rapid advancement of artificial intelligence (AI) has introduced both challenges and opportunities in education. As SoTL scholars, we are at a crossroads, facing existential questions about our roles, methodologies, and the very relevance of university education. In this chapter, I explore the ways AI intersects with SoTL, from enabling research methodologies to reimagining educational roles and responsibilities. Rather than reacting passively to technological shifts, we must take this opportunity to ask the questions at the heart of education: Who are we? Why are we? Ultimately, this chapter will argue for a proactive and critical engagement with AI in education, ensuring that SoTL remains at the forefront of shaping the future of learning.

This All Feels Familiar: Stories From Software Engineering Education

AI is changing every field. A fundamentally new capability has been introduced in fields that had not been disrupted for a very long time. Yes, technology sometimes comes along that provides assistance, but the assistance was always nicely contained to helping—not to thinking. Now, there is something that will think for you, if you ask it properly. And most fields are not used to that kind of new thinking helper.

But actually, this all feels familiar to me, as a computer scientist. In the most basic terms, computer scientists program computers. We do a lot of things, but that is one thing we do. In the beginning, programming a computer meant moving levers, finding literal bugs, then punching cards, then writing simple commands, and then writing complex commands. Computer scientists refer to these changes as the introduction of levels of *abstraction* and, sometimes, the introduction of *indirection*—the programmer issues a command, and something indirectly happens. It is looking like AI is introducing our next level of programming abstraction.

To the outside observer, these levels of abstraction and indirection might just feel like tech progress—the way that a robot can replace a human at some simple tasks like moving rocks around a plane. But, in fact, in providing programmers with new levels of abstraction, these tools were doing some thinking too—they were making *choices* and saving us from having to make those choices. The robot is not only moving rocks around—it is playing chess! Where we used to train programmers to be really good at software optimization, a task that involved a lot of thought, understanding, decision making, and judgment, a computer would now do it, and we, for the most part, *would not have to worry about it any more*. If the newly introduced abstraction was a big enough disruption, with enough staying power, typically a Turing award went along with it.

What that meant was that programming was in a constant state of "*what does this mean for us*?" Now that we no longer had to worry about some things, what did that free us up to worry about instead? And this is exactly where many people, including those of us in education, and in particular in SoTL, find ourselves. What does this new decider/creator mean for us?

As we have seen since AI emerged in popular use, people feel a tremendous amount of concern. In software engineering, this concern always accompanied new abstractions. The software engineering fear had two distinct and

very different angles. The first is highly personal: will my skills be out of date, meaning I will lose my job? We are seeing waves of this in many fields, and especially programming, right now with AI. The other fear was very practical and grounded in the work itself: loss of command and control of the functioning of the machine. In delegating to the machine for some of the judgment and decision making, programmers give up some of our granular control. You can ask for something new, but that also means you cannot get into the weeds of how the command is carried out the way you used to be able to.

So, with new abstractions there is always this tension—you can speak in bigger structures, and you also cannot speak in smaller components any more. Where once you were able to say "I would like to book a flight at this time, from this airport, to this airport, with no stops in between," you are now forced to stay at the level of "I would like to go from City A to City B." There was always real fear that the new power would become a straitjacket or that it would lead programmers down the garden path and, years later, have us all regretting our choices as we looked at systems that were difficult to understand, difficult to maintain, and slow. The academic response was to write viral research papers entitled catchy things like "_____ *considered harmful*!"[1]

Objects were one of the most Turing-winning abstractions and brought in a whole new field of thought called *object-orientation*—it introduced a higher level of abstraction than the even highest level of abstractions it overlaid. Objects and the associated thought paradigm were first introduced in the 60s and people immediately wondered "*what does this mean for us*?" Some met the new abstraction with excitement, while others were concerned. "Objects considered harmful" papers proliferated. Certainly, there was a sense that objects could take over and resistance was needed. In fact, it took decades for objects to catch on, and they went through many alterations of their own before they really took hold as usable technology in programming. It took until the late 90s for objects to be practical enough to enter broad industrial use, then another decade for people to realise they did have their drawbacks. Now, I say hesitantly, we are at a good place with objects, more than 50 years in, using the useful parts and ignoring the less efficient aspects that always felt hokey. The associated software processes have also changed and matured, becoming more general and maybe a little less eager and goofy.

All the while, and still, these new abstractions had and continue to have impacts in software engineering education—while the field was grappling with what it meant to be a programmer now, educators struggled to figure out what to teach and how to teach it. Was it the responsible thing to teach objects even though barely anyone in industry was using them yet? Or should we have our students leave the hall of congregation with all the cool new tech under their belts and ready to embrace the new abstraction and process landscape? Imposter syndrome and insecurity abounded: teaching students usually means an educator has a pretty good understanding of the topic—in the case of new abstractions, this is just impossible.

Engaging in discipline-based software engineering education research and SoTL within software engineering was a real challenge, with the fear being that your reflection and inquiry might provide you findings about something that is no longer relevant a few years down the road! Why bother studying the right way to teach an abstraction that nobody is going to keep using?

With AI, the pace of adoption in the field and of worker obsolescence are significantly accelerated. AI came into popular use around two years ago, and we are already at the 30-year mark if going by the object-orientation timescale: We, at this moment, are struggling to figure out how AI fits into software engineering curricula and how to study its impacts and applications in education without our results going stale almost immediately.

1. The first of these offerings was the famous essay "Go To Statement Considered Harmful" by computing's prominent thinker, Edsger W. Dijkstra, who I am proud to say was my PhD supervisor's supervisor's supervisor's supervisor. Ironically, Dijkstra was arguing for more abstraction in his essay, not less. But because the title was so catchy, people tended to adopt it to argue against new abstractions.

But because of our past in software engineering education, we know how this will likely go, albeit way way faster. To some extent, the phases follow the path of the stages of grief, which, in a way, makes sense. We are grieving the loss of the solidity of the old practices and norms, and we are forced to embrace a new reality that we did not choose or create.

The first phase is denial, or the sense of "*this is likely nothing and will go away*." We are done with that step. We can see that it is in fact something, and that it is not going away. Industry is investing in it, laying off people because of it, and slowly and increasingly requiring our graduates to know how to use it.

The second stage is not exactly anger, but maybe more irritated bargaining—we are here. SoTL'ers in this stage might be tempted to take the position of publishing papers along the lines of "good news, learning the old way is still better." Yes, learning objects is neat, but learning structured programming (the thing that came before) is still a better bet. The SoTL equivalent of "AI considered harmful." A less software-specific example might be "are AI-assisted student essays better or worse?" This phase can last a very long time, if not forever (when interleaved with the next stage). In the case of objects, some bargaining is still happening, more than 50 years in, even through the phases when we taught it with enthusiasm and now with more maturity, perspective, and restraint. The problem for SoTL and AI is that the technology is so new and unformed that it is hard to ground enduring questions in it, besides using it as a lens through which to examine the act of learning. SoTL'ers at this stage may even hold off looking at the new tech in teaching and learning because there is just not enough to go on.

The third stage is embracing, but badly: we will teach it, but we will get it somewhat wrong. Maybe this maps to a depressed/depressing acceptance. We will pick the wrong angle on the abstraction, choose the wrong metrics of success, and teach people skills that do not quite end up being the ones that are required long term. Maybe something like "how to prompt the AI to generate good software tests?" (which is a really good question at the time of writing, but may seem quaint, naive, and even moot in a year). We will then perform SoTL and DBER associated with the not-quite-future-proof material. In this phase of object-orientation, software engineering will have to adjust its pedagogical structures and associated DBER to accommodate these shifts in abstraction by introducing courses on objects and associated practices. Papers in this stage will often have the new technology right in the paper title to distinguish the work as part of the new era and paradigm, even while the prior one is alive and relevant. Conferences will be named for the technology that arrives on the scene.

Some educators have entered this third stage, but most of us need to wait and see how our disciplines pick up this new technology in order to drive curriculum to meet downstream needs. This is the stage where students start asking irritable questions on forums such as "why aren't we using the new tech in class?" and, painfully for many of us, pointing out, "my instructor has no idea how to use the new tech." This is a very perilous time for SoTL because the easiest questions to ask are things like "how to mitigate hallucinations when teaching students programming?" But what happens to that result in six months when those specific hallucinations are no longer appearing? In fact, many of the most obvious questions will have a very short horizon for generalizability. Perhaps the role of SoTL in this stage is to keep asking *interesting* questions, and not ones that are tinged with irritation about the new thing or have a built-in expiry date. Asking "do hallucinations help or hinder students learning to code, and what does that say about coding skill acquisition?" is a better offering than "experience report on why hallucinations ruined my students' experience." Yes, there is always the fear that students will just not need to learn to write code *at all* in a couple of years, but at least we will understand something about the way students think and learn that can be transferred to whatever the new reality might be. In this phase, we need to position SoTL to interrogate how best to integrate AI-driven methodologies across all fields, even while those technologies and methodologies are changing.

The final stage is acceptance. We are definitely not here yet, and it may still be several years away, because the prior phase will continue as long as the technology continues to drive forward at its current breathless pace. In the acceptance phase, the dust has settled and the scope of use in the disciplines has been more or less established. That solidity affords a mature view on what to teach, so we can better inquire into how to teach it. We can start

asking questions like whether students' sense of belonging is influenced by the technology and whether this technology changes anything about the way classes should be set up in the first place. In software engineering, we are now writing papers about things like "student belonging in a second-year programming class" without mentioning that the technology being taught in the class is object-oriented. Ultimately, we will stop mentioning the technology in our paper titles because it will have become *just the way things are done*.

The path from denial to acceptance is not linear—it is now thought of as a tangle, and its course is very unique to each individual travelling it. SoTL as a field is currently tangled in all of the phases of denial, irritation, and embracing.

SoTL's New Abstraction: The Question

Perhaps the earliest obvious upside for SoTL, and maybe motivating the first steps into acceptance, is the role AI can play in analysis. AI-tools are already *pretty good* (the stage before robust) for extracting themes from qualitative data. Recently, my colleagues at the Institute for the Scholarship of Teaching and Learning at the University of British Columbia (UBC) and the Centre for Teaching and Learning at UBC used an AI tool to extract themes from anonymous open-ended responses. They calibrated the tool against data they had already analysed and found that the AI approach resulted in more complete themes than their manual efforts. Furthermore, the AI performed the task in a day, whereas their work had taken weeks.

Agility has always been a huge blocker to truly interesting questions—we were hindered in our scope and breadth by the sheer effort that qualitative analysis entailed. Because of that outlay, we would bound our questions to what was doable in certain timeframes:

- What can one ask in a semester?
- What can one ask in the month during summer when we have a moment for SoTL?
- What analysis can one do across the duration of a PhD?

This brings me back to programming—my grandfather-in-law did his PhD in the 70s in math using computers. The computer was the size of a room, and he was trying to show that you could use computers to do a certain kind of calculation. There were a lot of reasons this work was hard to do: computers were changing, and the technology was clunky and very slow. He had to book computer time, and the waitlists were long. As such, he had to ask a very specific question about a single calculation because he could not ask a more general question—it would have taken too long! At some tragic point, he tripped and dropped his entire thesis program on the floor—hundreds of punched cards fell in a jumble. It set him back weeks sorting them all back out. But now, nobody is dropping their computer programs on the floor, so nobody will have that risk. Nobody needs to book computer time. We can just *use computers*. And with advances in computing, computer scientists have been able to ask more and more complex questions, and even invent AI, something that will answer all our questions for us, and maybe start coming up with questions of its own!

SoTL is being fast-tracked from holding a rack of punch cards to having lightning-fast computers always at the ready. You can now speak in the abstraction of questions, instead of having to get into the weeds of determining your answer. With the right data to hand, we can now instantly ask questions like "do students seem more stressed in classes with more granular assessment schedules?" or "do students with higher scores in early assessments engage more, and more meaningfully, on the discussion forums? And if so, what characterises the difference in their engagement?" If we get the prompt right, we might get our answer back in a few minutes. That leaves us open to thinking about the implications of the answer and working through our pedagogical response to those implications. For instance, a current research initiative within a databases course is investigating whether AI can evaluate tone in student discussions and correlate sentiment with learning outcomes. Effectiveness is looking promising. This abstraction-elevation shifts

the paradigm from merely studying student engagement to actively uncovering hidden patterns in their learning experiences.

AI in SoTL practice is gaining ground. Child Trends reports that education researchers are utilizing AI to predict student outcomes, analyse qualitative data, and conduct literature reviews (Kelly et al., 2024). While these tools offer efficiency, concerns about accuracy, security, plagiarism, and ethics persist. Meanwhile, a systematic review by Ogunleye et al. (2024) highlights the lack of agreed-upon guidelines for using generative AI in higher education. The study calls for interdisciplinary research to develop frameworks and policies that ensure effective and ethical AI integration in teaching and learning .

Of course, AI's ability to generate insights is not synonymous with understanding—SoTL scholars are still the primary thinkers and question askers in the loop. There is still, and will likely always be, significant expertise needed to know which prompts to give to the machine. We can ask the tool to make suggestions about which analyses to apply, but it still feels tenuous to trust its advice without expert insight.

We are likely to see further proliferation of papers on AI for SoTL, sharing what works well and what does not work yet, when performing SoTL at this new level of abstraction. As AI facilitates new forms of analysis, and speeds up the old ones, it is imperative to robustly refine SoTL methodologies and peer-review the advances.

Common Cause; Unique Impacts

While AI is reshaping education broadly, its effects are not uniform across disciplines. Each field will experience AI-driven disruption in different ways, requiring tailored pedagogical responses from SoTL scholars. Understanding these varied impacts is essential for ensuring that AI integration supports disciplinary needs rather than imposing a one-size-fits-all approach.

Library and information sciences, for instance, will likely undergo a transformation akin to the digital revolution that redefined their field with the advent of computers. Just as library science had to reimagine cataloging, information retrieval, and research support when digital systems became dominant, AI now presents another seismic shift, automating aspects of knowledge organization and discovery. This raises fundamental questions about the role of librarians as curators of knowledge and the skills that will remain uniquely human. Discipline-specific questions might include "how does AI-driven automation affect students' ability to engage in independent research?" or "what role should librarians play in guiding AI-assisted inquiry?"

Computer science faces its own challenges, as AI increasingly encroaches on traditional programming tasks. With large language models capable of generating functional code, debugging, and optimizing algorithms, educators must reconsider what foundational skills students need. Should introductory courses focus less on syntax and more on systems thinking, software architecture, and ethical AI deployment? The role of computer scientists may shift from code authorship to higher-level system design and oversight. We have already discussed the kinds of questions that might be asked in the sub-field of software engineering, but computer science broadly is also shifting. SoTL scholars in computer science might end up engaging with questions like "hw should programming curricula evolve when AI can generate and debug code?" and "should courses shift toward systems design, AI ethics, or human-computer interaction?"

The sciences, particularly those driven by quantitative methods, are being accelerated by AI's ability to handle vast datasets, perform combinatorial analyses, and model complex phenomena with unprecedented efficiency. In fields such as biology, chemistry, and physics, AI is streamlining research workflows, suggesting new hypotheses, and automating experimental design. How do students interpret AI-generated scientific models? How can AI best be integrated into laboratory education without undermining traditional scientific rigor? This shift requires educators

to place greater emphasis on interpreting AI-generated findings, ensuring students understand the assumptions and limitations behind algorithmic analysis.

Social sciences are experiencing a different kind of disruption. AI's generative capabilities have profound implications for fields like psychology, sociology, and political science, where qualitative assessment and textual interpretation play a central role. AI tools can simulate human behaviour, analyse vast corpora of text, and even generate new qualitative data. This may force SoTL scholars to ask:

- How do we teach critical thinking and methodological rigour when AI can produce plausible but flawed narratives?
- How do we ensure that AI-driven research does not merely reflect the biases of its training data?
- How do students critically engage with AI-generated qualitative data?
- What safeguards are needed to ensure AI does not reinforce biases in sociological and psychological research?

The SoTL community can come together as a whole to help ask these questions—some answers will generalise across disciplines, and some will tilt into the discipline specific. Maintaining interdisciplinarity will help SoTL remain robust to the weaknesses introduced by silos that can plague communities and that can slow down the transfer of advancement and insight.

Exploring Existential Questions about Higher Education

As we watch AI emerge into something we can trust to take over large swaths of our executive functioning, we have to ask—where will it end? Can AI do a better job of teaching, or at least a cheaper job, than we educators can?

In the book *The Diamond Age: Or, A Young Lady's Illustrated Primer* by Neil Stephenson (2000), a little girl named Nell has parents who are plagued with the problems of those in poverty and could not secure a solid education for her. As such, Nell is left up to her own devices (literally) for any education she should want to achieve. Through a series of unlikely but tremendously fortunate events, Nell finds herself in possession of a tablet called a Primer, described as an infinite interactive book—Nell can ask the Primer anything, explore anything, and learn anything. *The Diamond Age* was written in 1995—20 years before tablets and 30 years before GenAI. We still do not quite have what Nell had, but it is getting eerily close—it is not that the tech cannot do what the Primer did in *The Diamond Age*, it is just that application developers have not quite had the time to do it…yet. By the end of the book, Nell has emerged as a leader and is intelligent and intellectually strong. As SoTL scholars, it behooves us to ask: *Would human teachers have done a better job?*

The Diamond Age strikes at the heart of a lot of the questions we are currently asking about education in the face of AI. Nell is only able to be educated to a sophisticated extent because of theft and luck (Stephenson, 2000). If education is tied to expensive delivery technology, will there be a divide between the haves and the have nots? The Primer is completely self-paced and uncurated—Nell is an uncommonly inquisitive child and seems to have an uncanny ability to ask the *right* next question to lead her to useful and usable outcomes. Can we assume that the same level of wisdom is present in most students? Or is there a risk that choose-your-own-adventure education would lead students deeper and deeper into conspiracy theories a la social media's self-reinforcing algorithms?

Recent studies have explored various applications of AI in education, highlighting both its potential benefits and challenges. A report by the U.S. Department of Education (2023) emphasizes that AI can automate actions to support student learning, but educators must ensure these actions comply with laws such as the Individuals with Disabilities Education Act. Similarly, research from the Center on Reinventing Public Education indicates that AI usage in U.S.

classrooms is currently limited, with more advantaged suburban districts leading in adoption, raising concerns about equitable access to AI's benefits in education (Lake, 2024).

We have no data about how students engage with an immersive AI educator, but we have some clues. Students did not flock to massive open online courses (MOOCs) the way we had expected, and MOOCs did not replace educators the way we feared. Why not? I can think of a few reasons, just drawing on my own experience:

- MOOCs are not choose-your-own-adventures, meaning a student cannot delve into areas of deeper interest or chart their own path through the material.
- Students cannot circle back if they are still unsure.
- Students cannot stray out of the lane of the material and explore adjacent topics.

MOOCs are a closed and finite world. AI, by contrast, is infinite, open-ended, and choose-your-own-adventure. But there are some drawbacks of MOOCs that AI may share. MOOCs seem to require a mature commitment from a learner with strong time management skills—ultimately, the students have the freedom to just walk away. And learning in a MOOC can feel lonely—if the online community in the MOOC is quiet and there is no sense of cohort, then a student can feel like they are on their own with the material. We still do not know whether long-term tutelage from an AI would begin to feel closed and lonely and whether students would just walk away as they could and often did with MOOCs. Do we need human connection to deeply learn? Or to keep learning? Do we need someone who will be sad we do not show up to class to keep us showing up to class? These are SoTL questions.

New Forms of Dissemination: Beyond the Paper

Traditional academic dissemination methods—conference presentations, journal articles, and books—are being challenged by AI-driven approaches that allow for new forms of engagement with research findings. One emerging possibility is the use of AI-powered conversational agents, such as custom GPT models, to allow researchers, educators, and the public to explore findings dynamically. Rather than reading static reports, users could engage with a dataset, ask questions about the research, and generate customized insights in real time.

Imagine a research project on student engagement where users could interact with an AI model trained on the dataset, posing questions such as:

- What were the key themes that emerged?
- How did students with different backgrounds respond?
- What factors were most correlated with learning gains?

Instead of flipping through appendices or supplementary materials, users could receive direct, nuanced responses tailored to their inquiries. The portal could allow consumers to fully explore the extent of the researcher's inquiry but would also catalyse follow-up exploration. One could command "perform their analysis but with my dataset and report on whether we see the same effect" or "given their findings, could you get at this inference they didn't think of?"

This would likely deconstruct, to a disturbing extent, the boundaries of what would be considered one's own contributions to the field. That deconstruction will feel very uncomfortable. Our academic intellectual property has been protected up until now by the natural barrier of the sheer difficulty of doing the work. If the work is easy, then what does that mean? What do tenure and promotion cases look like? What metrics would be used? Would we need a different calculus to measure impact?

However, this shift also raises significant short- and medium-term challenges. While the technology is in flux, how do we ensure that AI-generated responses accurately reflect the nuances of the research? How can we maintain academic rigour in a system where responses may be generated probabilistically? These are critical questions that SoTL scholars must address as AI becomes an integral part of the research dissemination process.

Conclusion

SoTL must not simply react to AI. The time for denial or even passive adaptation is over. It is imperative that SoTL scholars lead conversations about AI's role in education, ensuring that pedagogical values and ethical considerations are not sacrificed to efficiency, cost effectiveness, or confusion. As AI reshapes the educational landscape, SoTL scholars must be at the forefront of defining what teaching and learning will become and invest heavily in interrogating the range of its possibilities. We must deliberately chart a course that preserves what is essential, innovates where possible, and asserts a vision for education and inquiry that ensures AI serves human learning rather than replaces it. We can rise above asking questions based in cynicism or skepticism to those helping us understand ourselves, our learners, the role of education, and the very form it can take.

References

Lake, R. (2024, May). AI is coming to U.S. classrooms, but who will benefit? *Center for Reinventing Public Education.* https://crpe.org/ai-is-coming-to-u-s-classrooms-but-who-will-benefit/

Kelly, C., Holquist, S., Kelley, S., & Aceves, L. (2024, December 10). Promising applications of AI in education research. *Child Trends*. https://www.childtrends.org/publications/applications-ai-education-research

Ogunleye, B., Zakariyyah, K. I., Ajao, O., Olayinka, O., & Sharma, H. (2024). A systematic review of generative AI for teaching and learning practice. *Education Sciences*, 14(6), 636. https://doi.org/10.3390/educsci14060636

Stephenson, N. (2000). *The diamond age: Or, a young lady's illustrated primer*. Spectra.

U.S. Department of Education. (2023). *Artificial intelligence and the future of teaching and learning* [PDF]. https://www.ed.gov/sites/ed/files/documents/ai-report/ai-report.pdf

11. Challenging Assumptions About HyFlex Teaching with Students as Partners

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Introduction

Undergraduate students in our context are clamouring for flexibility in their education. Some need flexibility because of disabilities, while others are juggling caregiving or employment responsibilities. Some worry about the ongoing health risks of attending lectures during a pandemic or some need flexibility because they are sick. Some students are unable to afford housing near campus, forced to weigh the risks of a snowy drive or late-night bus ride in deciding whether they can safely come to class.

We learned all this from listening to undergraduate students in the Honours Life Sciences program at McMaster University, first informally and then formally through surveys and focus groups. McMaster University is located in Ontario, Canada, and is home to over 30,000 undergraduate students across five faculties each year. The Honours Life Sciences program is the largest undergraduate program at McMaster, with over 1,026 students enrolled during the 2022–2023 academic year.

The students to whom we have listened to make a compelling case for hybrid-flexible (HyFlex) learning environments, wherein they have the option to learn in a physical classroom or virtually depending on their circumstances and preferences. However, some instructors worry about attendance crashing and pulling student grades down with it. Other instructors feel there are important benefits to being in the classroom, including opportunities to connect with professors and peers, while other instructors fear the burden of creating a HyFlex learning environment and supporting all the students within it.

So, we must ask important questions:

- Can we honour student preferences without harming their learning experience or the teaching experience of instructors?
- Does providing the flexibility that students want and, in many cases, need diminish the learning experience for some, or could it enhance the learning experience for all?

Asking these questions requires challenging our assumptions as both teachers and learners.

Our student-partnership approach to this study was intended to address power imbalances between the instructor and student by collaborating with students in the research process, rather than conducting research on students (Mercer-Mapstone et al., 2017). This aligns with our underpinning desire to prioritize the individual perspectives of students and enable agency in how students engage in their learning (Miller-Young & Yeo, 2015; Crompton, 2013).

By using both quantitative and qualitative methods and a transparent lens, our study fits within the category of a neopositivist paradigm (see **Chapter 2**). We reflect our research philosophies in our student-partnered-informed, multi-method study that combines grades, measures of engagement, surveys and focus groups, through which we listened carefully to diverse perspectives and thought critically about the aims and outcomes of our HyFlex teaching practice at McMaster University. In sharing our approach and findings, we hope to provide a compelling case for

student-partnered research that examines, both quantitatively and qualitatively, the impact of honouring student needs and preferences by incorporating flexibility into higher education through the use of technology.

The authors of this chapter contributed in various roles to the design, delivery, and interpretation of this research:

- **Zoya Adeel** and **Stefan Mladjenovic**, as students in a participating HyFlex course, informed the study design and interpreted the findings as student partners.
- **Kate Brown** provided insight on the design and research findings through her lens as an expert in diversity, equity, and inclusion in post-secondary education.
- **Dr. Sara Smith** conducted the data analyses.
- **Dr. Katie Moisse**, the instructor of all participating HyFlex courses and the study's primary investigator, led the overall design, delivery, and interpretation of this research.

HyFlex Learning Environments

The term "HyFlex" describes "class sessions that allow students to choose whether to attend classes face-to-face or online, synchronously or asynchronously" (Beatty, 2019). According to Beatty, HyFlex courses (Chapter 1.3):

- give students agency over how they will attend a session;
- provide equivalent learning activities in all modes;
- use the same learning objects for all students;
- ensure students are equipped with the technologies and skills to participate in all modes; and
- employ authentic assessments that are relevant and have real-world applications.

Prior research evaluating HyFlex has generally found that the option to attend class either in person or online does not negatively affect student attendance, engagement, or final course grade (Groen et al., 2016; Lakhal et al., 2014; Miller et al., 2013; Adeel et al, 2023). Miller et al. (2013) found that when students are provided the option to attend class asynchronously with recorded lectures, 61% of undergraduate students self-reported that they did not miss any class in an undergraduate HyFlex statistics class (n = 157). They also found no difference between homework grades, midterm scores, and final course grades between students who attended the course synchronously in person or online. Similar research conducted by Lakhal et al. (2014) found no significant differences in student satisfaction, multiple-choice texts, and written exam scores between students who chose different attendance modes. Another study found that HyFlex learning environments were associated with an increase in course enrolment and student satisfaction (Sowell et al., 2019).

We sought to validate these findings in our context with a Students as Partners approach to elevate the perspectives of students and enable agency in how students engage in their learning. We also aimed to counter key assumptions of our instructors and administrators related to online and HyFlex learning in undergraduate classrooms.

Echo360 as a HyFlex Teaching and Learning Platform

Echo360 is an educational technology that can be leveraged to align with Beatty's five fundamental principles of HyFlex courses. It complies with provincial accessibility standards and is institutionally supported at McMaster University and, therefore, free for students and instructors to use. More than 90 McMaster classrooms are equipped

with equipment that enables instructors to schedule synchronous live streams of their lectures and/or record lectures for later, asynchronous viewing using Echo360. Even in classrooms without a built-in Echo360 system, instructors can livestream and record from their laptops. All recordings generate a searchable transcript that can be applied to closed captions.

Instructors can use Echo360 features to engage students in active learning. For instance, they can embed interactive slides that use polls or short-answer questions to gauge students' understanding of concepts or solicit their perspectives for discussions. A Question & Answer feature allows instructors and students to share queries, comments, and files, with or without anonymity. Students and instructors can respond to and endorse comments, creating a vibrant online discussion in addition to any in-person discussion. Students can also anonymously raise a "confusion flag" when concepts are unclear, prompting the instructor to clarify. Importantly, students can engage with these features anonymously, which is more comfortable for some students than speaking out in class (Hoekstra, 2008).

Echo360 also provides analytics that can help instructors monitor student engagement, if they wish. Instructors can measure attendance and engagement with interactive slides. They can link these metrics to their learning management system so that attendance and/or participation contribute to student grades. In our experience, attaching a small grade value to student engagement encourages attendance and participation. However, we recognize there are different views among instructors on the pedagogical merits of "participation marks" (Mello, 2010; Paff, 2015).

Designing and Conducting Research With Students as Partners

Our research originated from conversations with students in various venues—in the classroom while collecting midterm feedback, during office hours while meeting with students, and in round-table discussions with student groups. Students shared how much they wanted and needed flexibility and what it meant for them to have it. However, they understood that sharing their experiences in these forums alone would not lead to broad adoption of HyFlex teaching practices. They needed data.

At the start of the 2019–2020 academic year, we formed a partnership to explore student experience with HyFlex teaching and learning. We decided to use Echo360 to create a HyFlex learning environment not only because of its active learning and accessibility features but also because of the data it could provide. We did not want to force students to engage either in person or virtually—flexibility was key. So, we designed an empirical study wherein we could compare outcomes between learners who chose to participate predominantly in person or online. We also used surveys and focus groups to explore student experiences of the HyFlex learning environment and better understand their desire for flexibility. Our multiple methods allowed us to better understand students' experiences of the HyFlex environment.

Over the past five years, we have used this approach to test five assumptions about HyFlex teaching and learning that we had informally gathered from instructors and students:

1. When given the option to participate virtually, in-class attendance will be low.
2. Students who participate primarily online will have reduced engagement and lower grades compared to those who participate primarily face -to -face.
3. Students perceive that a HyFlex format can support success, particularly students with flexible learning needs.
4. Our pre-COVID findings will hold up in a post-COVID context.
5. Students will report weak connections between peers and their instructors in a HyFlex learning environment.

We tested our first three assumptions during the 2019–2020 academic year and published these findings in The Canadian Journal of the Scholarship of Teaching and Learning (Adeel et al., 2023). We built on these findings to design a follow-up study in the 2022–2023 academic year that tests Assumptions 4 and 5.

Students were partners at every step of the research process. They decided which outcomes we should measure, wrote the ethics protocols, co-designed the survey questions, ran focus groups, analyzed data, shared findings at meetings and conferences, and submitted their work to a pedagogical research journal. This partnership has been critical in asking meaningful research questions and getting honest input from students. It has also forced all of us—students and instructors alike—to challenge the assumptions we make about the best ways to teach and learn.

Below, we describe our ongoing study, which has so far spanned four years with seven student researchers and 875 student participants. We hope that by describing our process, we can inspire others to stay reflexive in their teaching practice as student needs and institutional environments evolve.

Study Design

Context

Our study began in the 2019–2020 academic year when we ran two third-year life sciences courses in a HyFlex format using Echo360. Students were required to participate synchronously, either in person or online, and asked to share their mode of participation at the start of each class in a polling question. They were also asked to engage with interactive slides during class (synchronously) and in preparation for class (asynchronously) based on required readings/viewings. Synchronous attendance during class time and polling participation before and during class contributed to an "engagement score" worth 4–5% of students' final grade, depending on the course. The methods are detailed in Adeel et al. (2023).

Both courses were lecture-based, with 125–150 students, but they differed in their disciplinary focus and format:

- LIFESCI 3P03: Science Communication in the Life Sciences, is a skills-based course that is highly interactive.
- LIFESCI 3Q03: Global Human Health and Disease, is a content-based course that is moderately interactive.

The interactivity forms the rationale for requesting synchronous attendance: We believe students benefit from listening to and sharing perspectives in real-time. All students enrolled in LIFESCI 3P03 and LIFESCI 3Q03 were informed at the start of the term that their Echo360 engagement and grades were being collected for research purposes.

Our study continued during the 2022–2023 academic year, using the same methods as in the 2019–2020 cohort but in a post-COVID context. We focused on LIFESCI 3P03 and a large-enrollment second-year life sciences course, LIFESCI 2AA3: Introduction to Topics in the Life Sciences. As before, students were required to participate synchronously, either in person or online, and were asked to share their mode of participation and engage with interactive slides during class.

LIFESCI 3P03 remained unchanged from the 2019–2020 to the 2022–2023 academic year, while LIFESCI 2AA3, a skills-based and interactive, enrolled nearly 300 students. All students enrolled in both LIFESCI 3P03 and LIFESCI 2AA3

were informed at the beginning of the term that their Echo360 engagement and grades would be collected for research purposes.

Methods

To test **Assumption 1**—when given the option to participate virtually, in-class attendance will be low—we compared student attendance between in-person-dominant and online-dominant learners in both cohorts. In-person-dominant learners participated in more than half of the course lectures in person; while online- dominant learners participated in more than half of the lectures virtually.

Next, to test **Assumption 2**—students who participate primarily online will have reduced engagement and lower grades compared to those who participate primarily face to face—we compared student engagement and final grades between in-person-dominant learners and online-dominant learners. Final grades were adjusted to remove the contribution of the engagement score. Students that attended class in person or online more than half the time were categorized as in-person dominant or online-dominant learners, respectively, and those that attended class in person and online evenly were categorized as "equal." Statistical analyses associated with testing Assumption 2 were conducted in R (v.4.4.2, R Core Team 2024).

To test **Assumption 3**—students perceive that a HyFlex format can support success, particularly students with flexible learning needs—we also conducted a survey and focus groups to understand why students want or need flexibility and to explore their perceptions of a HyFlex teaching and learning platform. In November 2019, we sent a questionnaire to all life sciences students. We had 238 respondents, 11 of whom also signed up to participate in a one-hour focus group facilitated by two student partners. The questionnaire included 24 items and included both multiple-choice and short-answer questions. The focus group included a guided discussion that probed deeper into students' experiences in the Hyflex classroom.

To test **Assumption 4**—our pre-COVID findings will hold up in a post-COVID context—we repeated our study in the 2022—2023 academic year in LIFESCI 3P03: Science Communication in the Life Sciences, and LIFESCI 2AA3: Introduction to Topics in the Life Sciences. Both courses are skills based and highly interactive, with 300 students each. We sent an updated version of our questionnaire to students enrolled in either course after the end of the term to gather their perspectives on learning in a Hyflex classroom. The updated questionnaire expanded on the previous survey, incorporating additional questions that explored the student experience of attending class in person or online in a Hyflex setting. This allowed us to probe further on sentiments related to online learning that emerged during the pandemic.

To test **Assumption 5**—students will report weak connections between peers and their instructors in a HyFlex learning environment—we asked students in the 2022–2023 academic year to report how their peer's virtual participation in class impacted their sense of connectedness in an in-person setting in the questionnaire.

Findings

Assumption 1: When Given the Option to Participate Virtually, In-Class Attendance Will Be Low

When given the choice to participate in the classroom or virtually, in the 2019–2020 academic year, a slight majority of students came to class over half of the time (**Figure 11.1**). On average, in-person-dominant learners attended 79% of their classes in person in LIFESCI 3P03 and 71% in LIFESCI 3Q03. Online-dominant learners attended 71% of their classes online on average in LIFESCI 3P03 and 79% in LIFESCI 3Q03.

LIFESCI 3Q03 had more online-dominant learners than LIFESCI 3P03 (51% vs 35%), but it is worth noting that LIFESCI 3Q03 ran in the winter of 2020, when COVID-19 forced universities to close in March and the students were required to attend class virtually for the last three weeks of the semester. Based on previous experience in large-enrolment courses, we feel that having 53% in- person-dominant learners refutes our assumption that in-class attendance will plummet. It is worth noting that attendance typically fluctuates across the semester and did in our case:

At the start of LIFESCI 3P03, 70% of students participated in person, 22% participated online, and 9% did not respond to the polling question. Towards the end of term, 41% of students participated in person, 53% participated online, and 6% did not respond to the polling question. In both classes, we had a greater than 90% attendance rate, which we suggest would have been lower if the online option was not available.

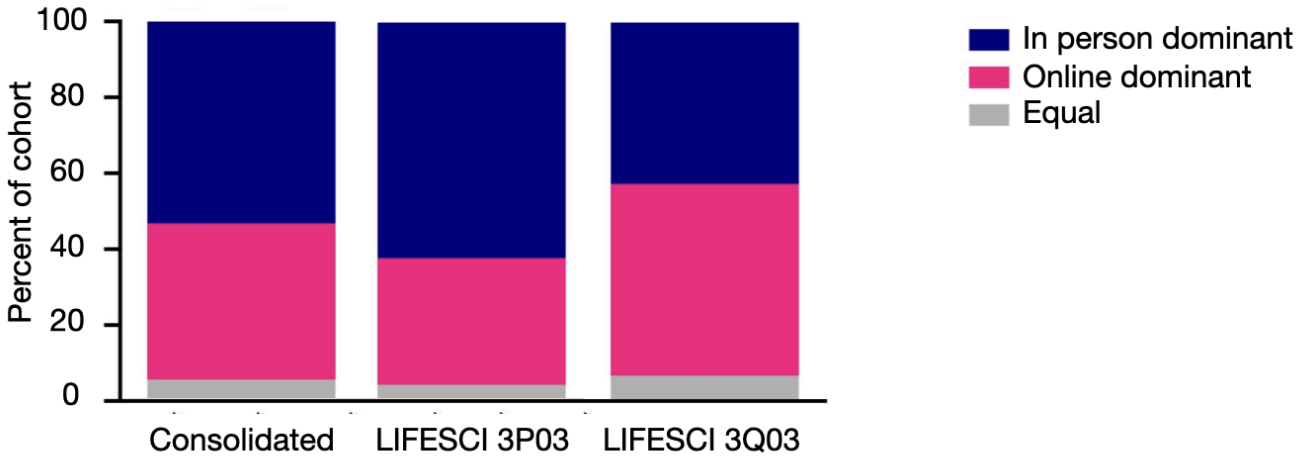

Figure 11.1 *When given the option to participate either in person or online, 53.5% of students in the 2019–2020 offerings of LIFESCI 3P03 and LIFESCI 3Q03 came to class more often than they attended online (n = 273). There were more in-person-dominant learners in the fall 2019 offering of LIFESCI 3P03 than in the winter 2020 offering of LIFESCI 3Q03, which pivoted entirely online for the last three weeks of the term. These last three weeks were not included in this analysis. Figure adapted from Adeel et al., (2023).*

Assumption 2: Students Who Participate Primarily Online Will Have Reduced Engagement and Lower Grades Compared to Those Who Participate Primarily Face-To-Face

We compared the engagement scores and final grades between in-person-dominant and online-dominant learners across both cohorts using Kruskal-Wallis tests to assess differences between these learners. We assessed both the engagement in course content and the final grade between modes of delivery. We saw no difference in engagement score or final grade (adjusted to remove the 4–5% contribution of the engagement score) between the two types of learners in both LIFESCI 3P03, a skills-based course, and LIFESCI 3Q03, a content-based course (**Figure 11.2**). This suggests students can be successful in our courses by making their own decision about the participation mode that works for them, even in highly interactive learning environments.

Using the Pearson correlation test, we saw a correlation between engagement score and final grade in both groups (**Figure 11.3**).

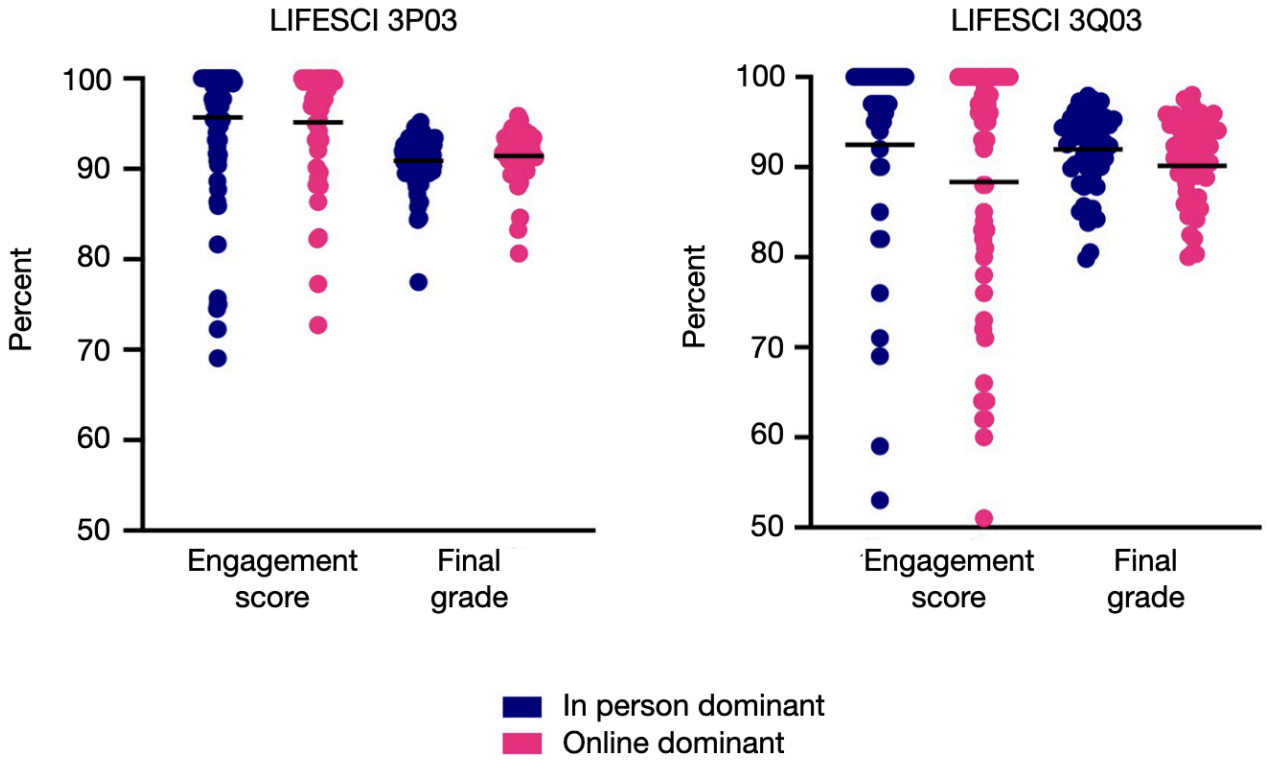

Figure 11.2 *There was no difference in engagement score or final grade between in-person-dominant and online-dominant learners LIFESCI 3P03 or LIFESCI 3Q03. Figure reproduced from Adeel et al. (2023)*

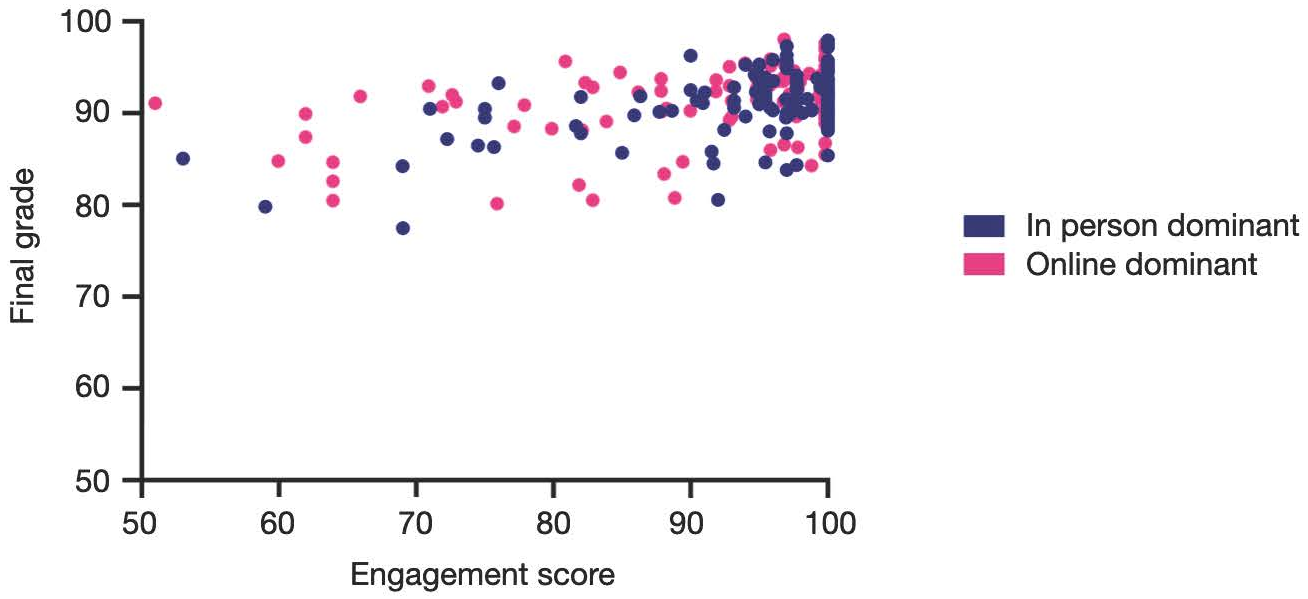

Figure 11.3 *Engagement score correlated with final grade in both LIFESCI 3P03 and LIFESCI 3Q03, as well as in the consolidated cohort (r = 0.4106 for in-person-dominant learners; r = 0.6259 for online-dominant learners; $p < 0.0001$ for both groups; n = 259). Figure adapted from Adeel et al. (2023).*

Assumption 3: Students Perceive That a Hyflex Format Can Support Success, Particularly Students With Flexible Learning Needs

Of the 1,198 honours life sciences students that were invited to participate, we received 238 responses to our survey probing students' perceptions (response rate of 19.9%). Of the 238 survey respondents in the 2019–2020 academic year, 209 (88%) identified at least one flexible learning need, such as commuting, working one or more jobs, or speaking a first language other than English (Adeel et al., 2023, **Figure 11.4**).

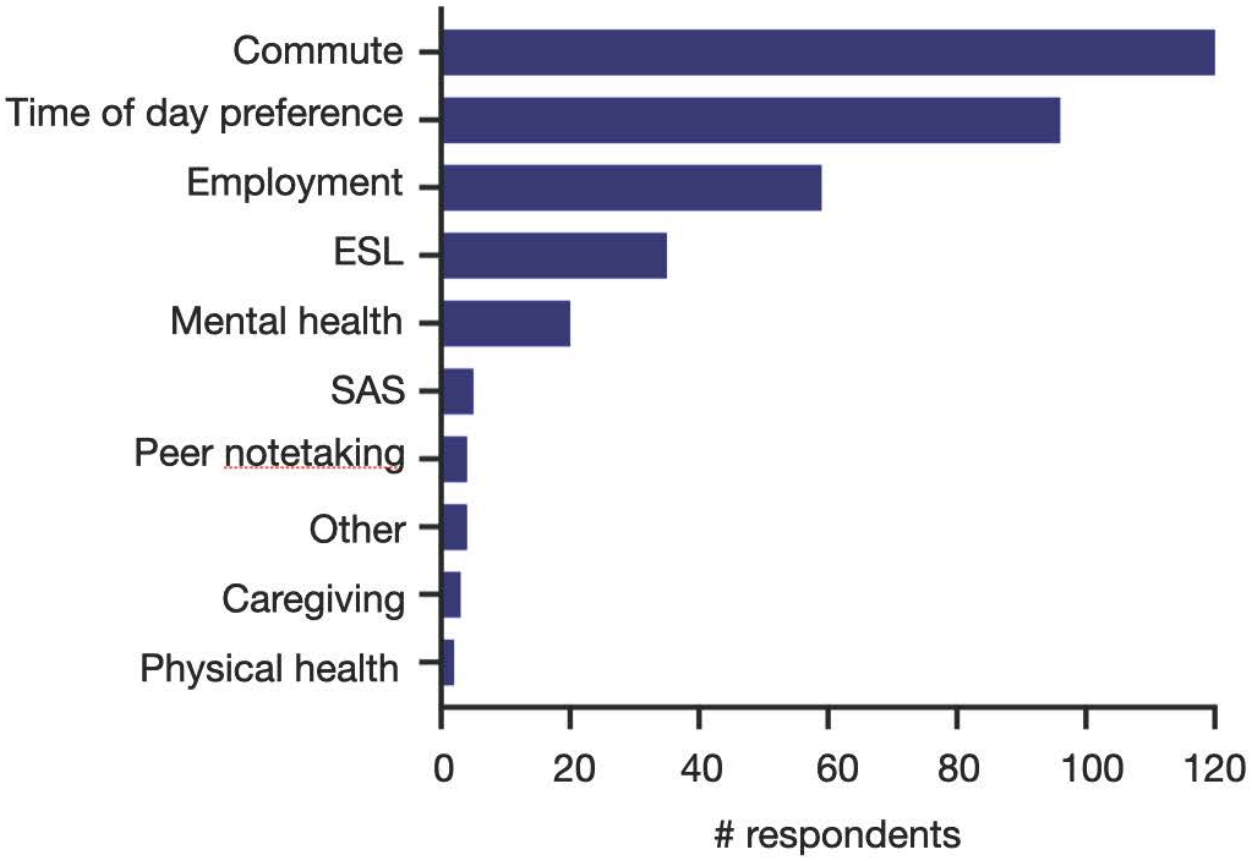

Figure 11.4 *Students report their flexible learning needs (n = 238). SAS: Student Accessibility Services; ESL: English as a second language. Figure reproduced from Adeel et al. (2023). [Long Description available]*

We also asked students to reflect on their experience with Echo360 (**Figure 11.5**). Among students who had used the platform (n = 189), 92% said using Echo360 made course content more accessible and 84% said it aided their understanding of course content. Importantly, of the 173 students who had used Echo360 and identified at least one flexible learning need, 172 (99%) said Echo360 benefitted them in some way. This suggests students perceive a benefit to HyFlex learning environments and feel it supports their success.

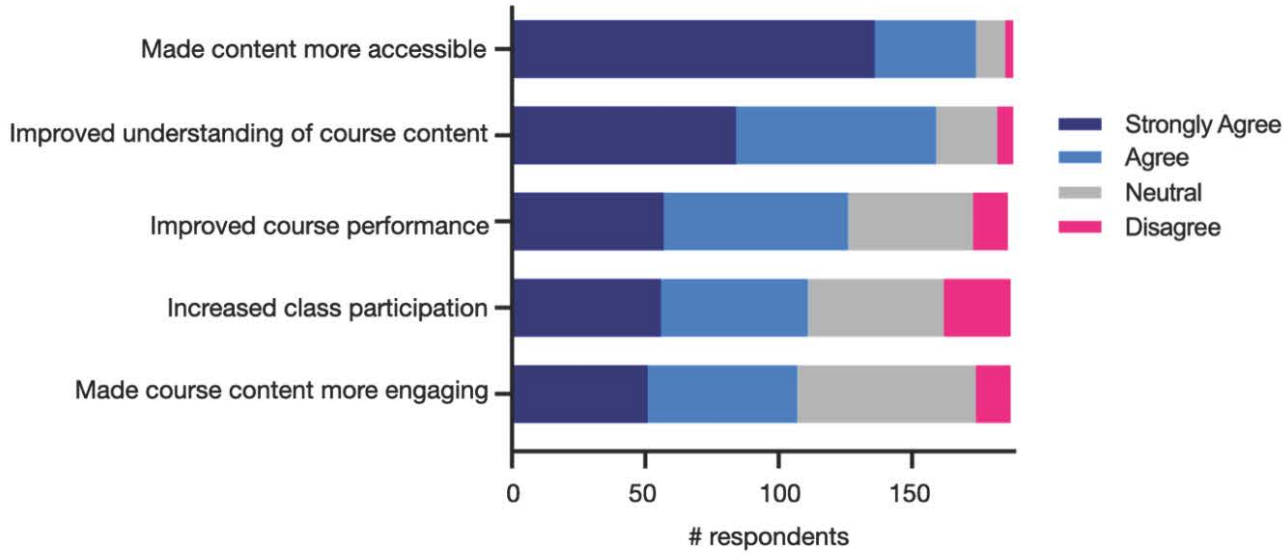

Figure 11.5 *Students reflect on Echo360 as an educational platform and its benefit to their learning (n = 189). The Disagree result was pooled from Strongly Disagree and Disagree due to few responses. Figure reproduced from Adeel et al. (2023).*

In our focus groups, students shared that they want to come to the classroom but want the option to participate virtually when necessary. "I would still rather go to class, but if you can't come, it still leaves you with other options," one student shared. "It's that second option if you can't make it to lecture," another said. For some students, though, the virtual option made learning more comfortable. "I think it is easier to be online. Sometimes it can be intimidating to go in," one student shared. "It's also convenient. My schedule doesn't always work with office hours, so I can just ask questions on the discussion [board]."

Assumption 4: Our Pre-Covid Findings Will Hold Up in a Post-Covid Context

Our data from the 2019–2020 academic year provided compelling evidence for HyFlex learning environments in large-enrolment courses. However, we did not want to assume that our pre-COVID findings would hold up in a post-COVID context, wherein some instructors have noticed significant drops in attendance and student grades.

When given the choice to participate in the classroom or virtually in the fall of 2022, most students chose the virtual option most of the time (**Figure 11.6**). In LIFESCI 2AA3, 216 out of 300 students (72%) attended more than half the classes virtually, and 16 (5%) attended every class virtually. In LIFESCI 3P03, 237 out of 300 students (79%) attended more than half of the classes virtually and 57 (19%) attended every class virtually.

On average, in-person-dominant learners attended 93% of their classes in person in LIFESCI 3P03 and 92% in LIFESCI 2AA3. Online-dominant learners attended 91% of their classes online on average in LIFESCI 3P03 and 93% in LIFESCI 2AA3.

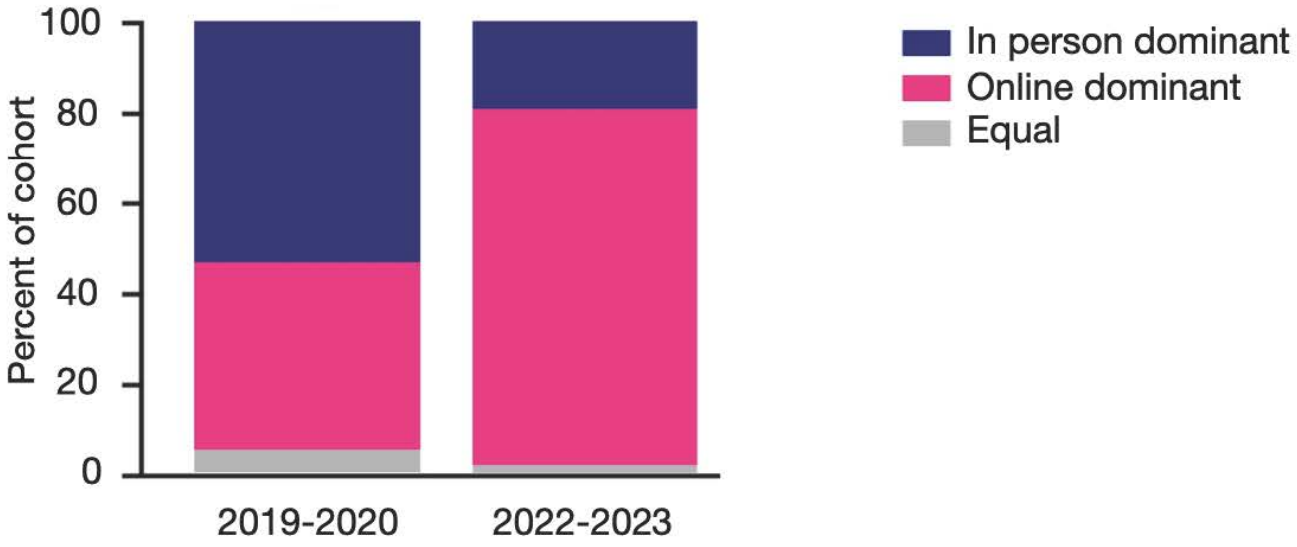

Figure 11.6 *There was a greater proportion of online dominant learners in our 2022–2023 cohort than in our 2019–2020 cohort.*

Despite a shift toward virtual attendance, we still saw no difference in final grades between in-person-dominant and online-dominant learners using a Kruskal-Wallis test ($p = 0.222$, **Figure 11.7**). This aligns with our previous findings and gives us more confidence that participating primarily online does not negatively impact student achievement. We did, however, see a small but statistically significant dip in engagement scores among online-dominant learners compared with in-person-dominant learners ($p = 0.00272$). We once again saw a correlation using the Pearson test between engagement and final grade ($p < 2.2e - 16$), suggesting that perhaps interactivity and engagement are more important to student success than whether they are in person or online. However, testing this interpretation would require further research.

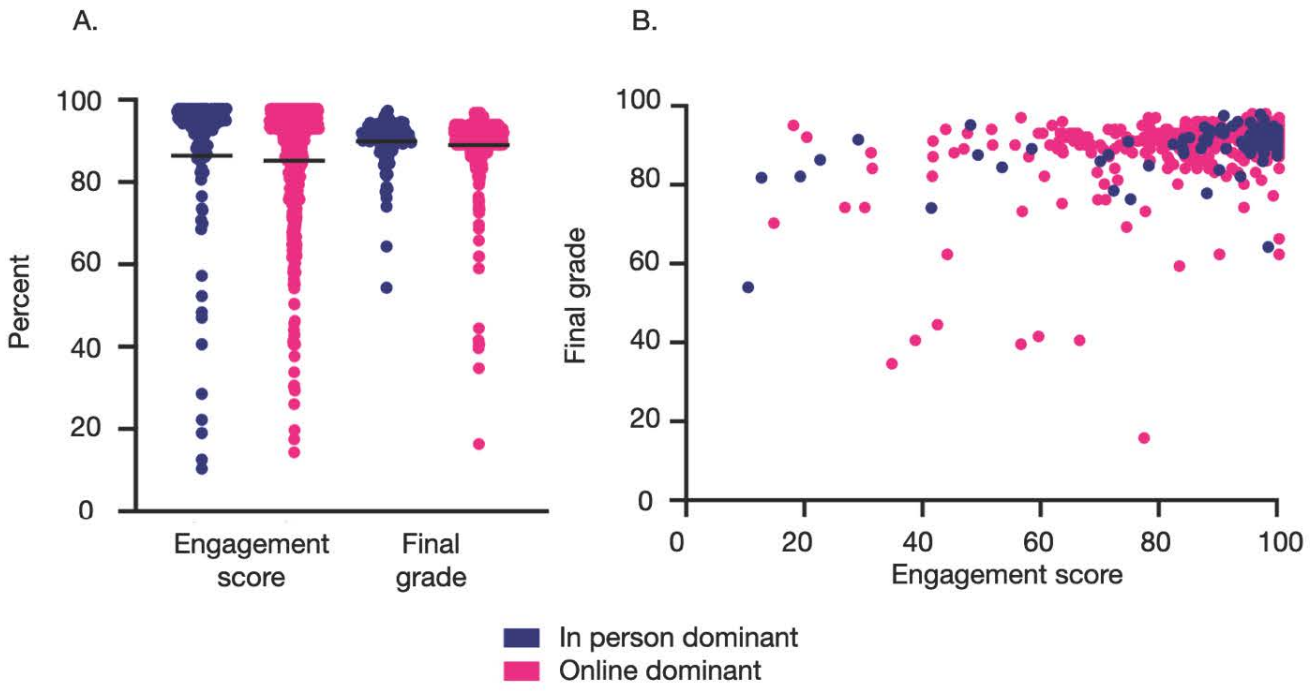

Figure 11.7 *A. There was no difference in engagement score or final grade between in-person-dominant and online-dominant learners in our 2022–2023 cohort (n = 579). B. Engagement score correlated with final grade in our 2022–2023 cohort (r = 0.5531 for in-person dominant learners; r=0.3738 for online dominant learners; p < 0.0001 for both groups; n = 579).*

For the implementation of the fall 2022 survey, roughly 800 students were invited to participate, and 109 responses were received. About 70% of respondents said they attended at least one class virtually because they were unwell, and 32% said they attended at least one class virtually because they were worried about getting sick. Conversely, 5% of students said they attended at least one class in person because they did not have the resources—such as technology, Wi-Fi, or a quiet space—to attend class virtually. These findings support the need for HyFlex learning environments wherein students can choose how to learn based on their circumstances.

We also used the survey to explore student perceptions of our HyFlex courses. All 109 respondents either agreed or strongly agreed with the statement "I benefited from the flexibility of being able to participate in this course either in person or online." About 93% either agreed or strongly agreed with the statement "The option to attend class synchronously online made me more likely to attend lectures in this course." And about 69% either agreed or strongly agreed with the statement "My attendance in this course was higher compared to courses that are only in person." These findings suggest that students want flexibility, are more likely to participate in a HyFlex learning environment, and feel flexibility enhances their learning experience.

In open-field responses, students expressed appreciation for flexibility and choice. In fact, some shared that flexibility heavily influences their course selections. "The option to participate in class online/have lectures recorded is a huge component when I'm deciding what courses to take. I get sick often and it is hard for me to come to campus for every class, so having an online option is ideal," one student shared. "The online option made me decide to take the course. I like to have the flexibility and the opportunity to listen [to] the lectures again and again to better understand and practice the course content," another reported. Another said, "Thank you for allowing students to make their own decisions for their learning."

Assumption 5: Students Will Report Weak Connections Between Peers and Their Instructors in a Hyflex Learning Environment

We asked students in our HyFlex courses from the 2022–2023 academic year how connected they felt with their peers and their instructor. About 67% of respondents said they felt very or somewhat connected to their peers, and 82% of students said they felt very or somewhat connected to their instructor. Interestingly, 44% of students said they felt more connected to their peers in their HyFlex course than in courses that are in person only, compared with 35% who said they felt less connected to their peers. Additionally, about 72% of students said they felt more connected to their instructor, compared with 16% who said they felt less connected. The findings from our focus groups suggest HyFlex learning environments can create additional avenues for connection that may be more comfortable for some students. Indeed, our survey found that roughly 92% of students either agreed or strongly agreed with the statement "I was more likely to participate and ask questions because I had the option to attend class based on my preferences."

Conclusion

Our findings validate previous findings that student attendance and academic outcomes are not negatively affected by having the option to attend class virtually. We demonstrate this with empirical evidence and from the perspectives of students. We did find evidence of an increased preference for online learning and a small decrease in engagement among online-dominant learners in our most recent cohort, but we continue to see a correlation between engagement and final grades among both in-person-dominant and online-dominant learners.

We sought to test five assumptions about HyFlex teaching and learning. Our findings do not outright refute the assumption that in-class attendance will plummet if students have the option to participate virtually. During the fall 2022 offering of LIFESCI 3P03, in-person attendance varied from 46% at the start of the term to 12% at the end of the term. That said, we still had 90% attendance at the end of the term, which is high relative to other large-enrolment courses with no virtual option. The observed shift toward greater virtual participation in the post-COVID context suggests the benefits of coming to the physical classroom need to outweigh the perceived risks and costs (i.e., the risk of illness, the cost of commuting, the cost of time spent getting to and from campus instead of working or studying, etc.). This meshes with student responses to our survey about avoiding campus because of illness or the perceived risk of illness.

Students report that the HyFlex format can also support student attendance and success, particularly among students with flexible learning needs, in both pre-and post-COVID contexts. This change since the 2019–2020 academic year could reflect a shift in preferences now that students have more experience with virtual learning. It could also reflect an increase in flexible learning needs, including worries about getting sick. Of the 3,458 students with accommodations through McMaster's Student Accessibility Services in the 2022–2023 academic year, 1,135 had accommodations for missed classes, and/or work, 1,165 had accommodations to record lectures, and four requested remote learning access (Shih, 2023, personal correspondence).

Finally, our findings challenge the assumption that a HyFlex learning environment will weaken connections among students and with their instructors, as more students reported stronger connections with their peers and instructors in HyFlex courses than those who reported weakened ones. Because students chose their preferred mode of participation from week to week, it is possible that students who participated primarily online prefer online interactions, including the anonymity of asking questions and participating in polls through Echo360. It is important to acknowledge that some students (32% of survey respondents) felt that the option to participate virtually compromised the in-person learning experience. About half of these students participated primarily in person, and the other half primarily online.

This high percentage, combined with the experience of some students with reduced connections with peers and their instructor, highlights a critical consideration when creating and managing HyFlex learning environments: We must balance students' desire for flexibility with the consequences of providing it.

We are taking steps to modify our courses to address some of the concerns raised by our respondents. Specifically, we recognize that many students are now participating exclusively online. For these students, we are creating an online section of select courses in which lectures meet the highest standards of accessibility and can be experienced asynchronously (on a schedule), with virtual office hours and group projects. We will run, in parallel, a Hyflex offering of these courses for students who wish to participate primarily in person. This Hyflex offering could be run in a smaller classroom outfitted for Hyflex course delivery, thus addressing student concerns about the in-person experience.

Our student-partnered approach was essential in identifying common assumptions about HyFlex teaching and learning and designing research questions and methodologies that could meaningfully and ethically challenge those assumptions. Students bring valuable lived experiences to pedagogical research (Matthews, 2018). They also understand the need to set their personal preferences aside and understand perspectives different from their own (Mercer-Mapstone et al., 2017). The student partners on this project are exceptional listeners and critical thinkers, and our research is better for it.

Future Direction

We must continue to explore and identify the limits of HyFlex teaching and learning environments. Class size, level, and subject matter all influence course design, and it is very likely that certain types of courses are more amenable to HyFlex learning environments than others. We must also capture honest input from instructors to understand the perceived downsides of HyFlex teaching, including concerns about increased workload. A 2021 study found that faculty members felt less prepared to manage the intricacies of HyFlex teaching than those of in-person teaching. Although instructors saw the pedagogical merits of HyFlex instruction, they needed significant support and resources in designing and implementing a HyFlex course (Romero-Hall & Ripine, 2021).

In the next phase of our study, we wish to explore the impact of HyFlex learning environments on the number and nature of accommodation requests. The number of students with disability-related accommodations grew from 3,124 in the 2019–2020 academic year to 4,280 in 2021–2022 and 3,458 in 2022–2023. We now have evidence that, for some students, having a virtual avenue to learn means attending class when they otherwise would not. Students who miss class with any frequency may feel less prepared than their peers, and this lack of preparation may be a significant driver of accommodation requests. Students with disability-related accommodations have shared anecdotally that they benefit greatly from the option to participate virtually when needed. We plan to compare the number and nature of accommodation requests in HyFlex courses to the number and nature of requests in courses of similar sizes with similar assessment structures delivered in a traditional classroom environment. We endeavour to do this in partnership with students who have flexible learning needs, including students with disabilities.

We must continue to challenge our assumptions as teachers and learners as partners in discovering ways to make education more flexible and accessible. Our student-partnered approach strengthened the questions we asked and our approaches to answering them. We commit to further enhancing the quality and relevance of our work through meaningful partnerships with students. We hope our work will inspire instructors and students to partner in challenging assumptions at their institutions about the best ways to teach and learn.

Reflective Questions

We pose the following series of questions for the reader to reflect on:

- What are your assumptions about flexibility in teaching and learning? How can you challenge those assumptions in your classroom?
- How can current teaching practices be reframed to promote student agency over their learning?
- What are ways to leverage existing educational technology platforms to elevate the student learning experience, both in -person and virtually?
- How can assessments be adapted so they are fair to both in-person and online learners?

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References

Abdelmalak, M. (2014, March). Towards flexible learning for adult students: HyFlex design. In M. Searson & M. Ochoa (Eds.), *Proceedings of SITE 2014–Society for Information Technology & Teacher Education International Conference* (pp. 706–712). Association for the Advancement of Computing in Education. https://www.learntechlib.org/primary/p/130839/

Adeel, Z., Mladjenovic, S. M., Smith, S. J., Sahi, P., Dhand, A., Williams-Habibi, S., Brown, K., & Moisse, K. (2023). Student engagement tracks with success in-person and online in a hybrid-flexible course. *The Canadian Journal for the Scholarship of Teaching and Learning*, 14(2). https://doi.org/10.5206/cjsotlrcacea.2023.2.14482

Alsayed, R. A., & Althaqafi, A. S. A. (2022). Online learning during the COVID-19 pandemic: Benefits and challenges for EFL students. *International Education Studies*, 15(3), 122–129. https://doi.org/10.5539/ies.v15n3p122

Beatty, B. J. (2019). Beginnings: Where does hybrid-flexible come from?. In *Hybrid-flexible course design: Implementing student-directed hybrid classes*. Edtech Books. https://edtechbooks.org/hyflex/book_intro

Braun, V., & Clarke, V. (2013). *Successful qualitative research:* A *practical guide for beginners*. Sage.

CBC News. (2022, December 11). Union and McMaster University reach tentative agreement after 3-week teaching assistant strike. CBC. https://www.cbc.ca/news/canada/hamilton/mcmaster-university-ta-strike-1.6682069

Crompton, H. (2013). A historical overview of mobile learning: Toward learner-centered education. In Z. L. Berge & L. Y. Muilenburg (Eds.), *Handbook of mobile learning* (pp. 3–14). Routledge.

Daymont, T., Blau, G., & Campbell, D. (2011). Deciding between traditional and online formats: Exploring the role of learning advantages, flexibility, and compensatory adaptation. *Journal of Behavioral and Applied Management*, 12(2), 156–176.

De Bie, A., & Brown, K. (2017). *Forward with FLEXibility: A teaching and learning resource on accessibility and inclusion* (M. Brown & N. Mir, Illus.). McMaster University. https://pressbooks.pub/flexforward/

Groen, J. F., Quigley, B., & Herry, Y. (2016). Examining the use of lecture capture technology: Implications for teaching and learning. *The Canadian Journal for the Scholarship of Teaching and Learning*, 7(1), 8. http://dx.doi.org/10.5206/cjsotl-rcacea.2016.1.8

Hoekstra, A. (2008). Vibrant student voices: Exploring effects of the use of clickers in large college courses. *Learning, Media and Technology*, 33(4), 329–341. https://doi.org/10.1080/17439880802497081

Kohnke, L., & Moorhouse, B. L. (2021). Adopting HyFlex in higher education in response to COVID-19: Students' perspectives. *Open Learning: The Journal of Open, Distance and e-Learning*, 36(3), 231–244. https://doi.org/10.1080/02680513.2021.1906641

Lakhal, S., Khechine, H., & Pascot, D. (2014, October). Academic students' satisfaction and learning outcomes in a HyFlex course: Do delivery modes matter? In T. Bastiaens (Ed.), *Proceedings of World Conference on E-Learning* (pp. 1075–1083). Association for the Advancement of Computing in Education. https://www.learntechlib.org/primary/p/148994/

Mamboleo, G., Meyer, L., Georgieva, Z., Curtis, R., Dong, S., & Stender, L. M. (2015). Students with disabilities' self-report on perceptions toward disclosing disability and faculty's willingness to provide accommodations. *Rehabilitation Counselors and Educators Journal*, 8(2), 8–19.

Matthews, K. E. (2018). Engaging students as participants and partners: An argument for partnership with students in higher education research on student success. *International Journal of Chinese Education*, 7(1), 42–64. https://doi.org/10.1163/22125868-12340089

McCullough, K. (2022, August 15). *'Can't afford to focus on school': Mac students return to Hamilton with soaring inflation, housing crisis*. The Hamilton Spectator. https://www.thespec.com/news/hamilton-region/2022/08/15/mcmaster-inflation-housing-crisis.html

Mello, J. A. (2010). The good, the bad and the controversial: The practicalities and pitfalls of the grading of class participation. *Academy of Educational Leadership Journal*, 14(1).

Mercer-Mapstone, L. Dvorakova, S. L., Matthews, K. E., Abbot, S., Cheng, B., Felten, P., Knorr, K., Marquis, E., Shammas, R., & Swaim, K. (2017). A systematic literature review of students as partners in higher education. *International Journal for Students as Partners*, 1(1) 15–37. https://doi.org/10.15173/ijsap.v1i1.3119

Miller, J., Risser, M., & Griffiths, R. (2013). Student choice, instructor flexibility: Moving beyond the blended instructional model. *Issues and Trends in Educational Technology*, 1(1), 8–24. https://www.learntechlib.org/p/129818/

Miller-Young, J., & Yeo, M. (2015). Conceptualizing and communicating SoTL: A framework for the field. *Teaching and Learning Inquiry*, 3(2), 37–53. https://doi.org/10.20343/teachlearninqu.3.2.37

Omstead, J. (2022, November 7). *2,200 GO Transit workers on strike after failed contract talks, no bus service*. Global News. https://globalnews.ca/news/9257860/go-transit-strike/

Polewski, L. (2018, April 14). *McMaster and Mohawk closed due to potential ice storm—Hamilton*. Global News. https://globalnews.ca/news/4144730/mcmaster-and-mohawk-closed-due-to-potential-ice-storm/

Paff, L. A. (2015). Does grading encourage participation? Evidence & implications. *College Teaching*, 63(4), 135–145. https://www.jstor.org/stable/24760624

Popov, O. (2009). Teachers' and students' experiences of simultaneous teaching in an international distance and on-campus master's programme in engineering. *The International Review of Research in Open and Distributed Learning*, 10(3). https://doi.org/10.19173/irrodl.v10i3.669

Rogan, F., & San Miguel, C. (2013). Improving clinical communication of students with English as a second language (ESL) using online technology: A small scale evaluation study. *Nurse Education in Practice*, 13(5), 400–406. https://doi.org/10.1016/j.nepr.2012.12.003

Romero-Hall, E., & Ripine, C. (2021). Hybrid flexible instruction: Exploring faculty preparedness. *Online Learning*, 25(3), 289–312. https://doi.org/10.24059/olj.v25i3.2426

Shakil, I. (2022, November 4). *Ontario schools shut as some 55,000 education workers strike in Canada*. Reuters. https://www.reuters.com/world/americas/schools-shut-55000-education-workers-strike-canadas-ontario-2022-11-04/

Shingler, B. (2022, October 26). *What to know about RSV, a virus surging among young children in Canada*. CBC News. https://www.cbc.ca/news/health/rsv-canada-children-virus-1.6628778

Sowell, K., Saichaie, K., Bergman, J., & Applegate, E. (2019). High enrollment and HyFlex: The case for an alternative course model. *Journal on Excellence in College Teaching*, 30(2), 5–28.

Zerbini, G., & Merrow, M. (2017). Time to learn: How chronotype impacts education. *PsyCh Journal*, 6(4), 263–276. https://doi.org/10.1002/pchj.178

Media Attributions

All images in this chapter have been created by the author, unless otherwise noted below.

Long Descriptions

Figure 11.4. Long Description: The bar graph has the following approximate number of respondents for each flexible learning need:

- Commute: 120
- Time of day preference: 100
- Employment: 60
- ESL: 40
- Mental Health: 20
- SAS: 8
- Peer note taking: 6
- Other: 6

- Caregiving: 4
- Physical health: 2

[Return to Figure 11.4.]

12. Scholarly Design of Instructional Videos for Online and Flipped-Class Learning: Instructor Presence and Interactivity

RILEY PETILLION AND STEPHEN MCNEIL

Introduction

As part of a project to revise the first-year chemistry courses at the University of British Columbia's (UBC) Okanagan campus, a series of instructional videos were created for use in flipped-class learning modules. The development, implementation, and revision of these instructional videos has itself been a multi-year endeavour, informed both by multi disciplinary educational scholarship and by our own research studies, which helped us identify specific video design principles that students perceived to best support their engagement and learning.

Insights drawn from these studies, undertaken before the pandemic, dramatically affected our wider teaching practice both during and following the pandemic. This chapter offers a scholarly reflection by the authors on the evolution of this video design project and its wider impacts.

Institutional Context and Background

In collaboration with Dr. Tamara Freeman, one of the authors (McNeil) has undertaken a long-term project that has reformed all aspects of the content, delivery, and assessment of the introductory chemistry courses at UBC's Okanagan campus, which are taught as a sequence of two one-semester courses to approximately 700 to 800 students each year in classrooms of 300–400 students. In each semester, students attend approximately 30 hr of classroom activities (typically 22–24 lecture periods of 80 min) and 8–10 3-hr laboratory sessions. Given the proven advantages of active learning pedagogies (Freeman et al., 2014; Theobald et al., 2020), the course delivery was revised to align with educational principles of social constructivism (Kukla, 2000; Matthews, 1998; Pritchard & Woolard, 2010) by using active learning methods to create regular and prolonged in-class opportunities for students to interact and discuss course concepts and problems with one another. These activities include:

- the use of personal response systems with peer discussion (Terrion & Aceti, 2012; Liu et al., 2017; Smith et al., 2011);
- small-group (~4 students) guided-inquiry activities (Abraham, 2005);
- flipped-class modules that include prior viewing of instructional videos (Bokosmaty et al., 2019; Seery, 2015; Talbert, 2017);
- context studies guided by a systems-thinking perspective (Mahaffy et al., 2019; Orgill et al., 2019) to demonstrate application of course concepts to meaningful social, environmental, and scientific contexts (Petillion et al., 2019); and
- collaborative two-stage exams (Gilley & Clarkston, 2014; Kulak & Newton, 2014).

A significant guiding principle for this project was the explicit incorporation of affective learning

considerations, prompting a design of learning activities that considered matters of engagement and student satisfaction with their learning experiences in addition to course content.

Principles of Flipped Learning

In a traditional lecture pedagogy, learners are first exposed to course concepts in lectures and later apply their understanding by working through problems as homework. A flipped classroom inverts this sequence: students are first exposed to new content prior to class, then the classroom becomes an active learning environment where learners apply those concepts, with the instructor now guiding and facilitating learning activities rather than merely presenting information.

Our project to redesign our first-year chemistry curriculum began with a mapping exercise that identified appropriate learning objectives, the learning concepts required to achieve those objectives, and topics that would best support the development of those concepts. Rather than adopting a single delivery mode, we selected different delivery modes that we felt were best suited to particular concepts. The concepts and topics that we felt would most benefit from a flipped-learning approach were those for which a somewhat challenging conceptual basis might be first introduced via a short instructional video. This basis could then be developed and applied to a wider range of problems via a longer guided-inquiry activity during the following class session.

A large body of research and educational scholarship has demonstrated the learning benefits that can result from a flipped- or blended-learning approach and has identified best practices for the development and implementation of flipped-learning activities (Bancroft et al., 2021; Lundin et al., 2018; O'Flaherty & Phillips, 2015). Our flipped-class modules were designed accordingly:

Each of our flipped-learning modules comprise:

- a short (~15 min) instructional video
- a brief post-video conceptual quiz
- an in-class guided-inquiry activity that applies and expands upon the video concepts
- a short post-activity assessment

Within each module, learners spend the majority of their time working together during class, but their initial engagement with each concept is via the instructional video.

Instructional Video Design: Theoretical Frameworks and Practical Considerations

Before we began designing the instructional videos that would introduce our flipped-class modules, we undertook an analysis of relevant educational scholarship to identify design factors that most strongly influenced the ability of a video to act as an effective learning resource. Additionally, we surveyed common publicly-available sources of instructional videos for introductory chemistry topics.

We learned much from the work of Mayer, who has consolidated years of research to generate a short list of principles to guide instructional video design (Fiorella & Mayer, 2018; Mayer et al., 2020). Many of these principles

emphasize the pedagogical value of an on-screen instructor and identify instructor behaviours that promote both viewer learning and engagement. For example, Mayer recommends the use of dynamic drawing, where the instructor writes information on a board or screen in real time, rather than a format in which blocks of text spontaneously appear, as is often seen in digital slide presentations. We were also cognizant of the impacts of video design on viewer cognitive load: multiple studies found that cognitive load can be managed by segmenting a video into smaller meaningful portions and by allowing the viewer to regulate the playback speed and freely navigate the video timeline (Biard et al., 2018; Mayer, 2003; Merkt et al., 2011).

However, some of these principles stem primarily from studies using video-based technologies that were highly dated when we began this project. These principles generally assume that the video is a recording of an instructor at a writing board delivering an otherwise traditional lecture, yielding a video that duplicates the experience of a learner watching a passive lecture delivery. One example is Mayer's instructor gaze principle, which states that the instructor should regularly shift their gaze between the audience and the board on which they are writing; this principle assumes that an instructor and a physical writing surface share the same on-screen frame. Another is Mayer's "interactivity" principle, which encourages the use of interactive features, but the features described in the studies upon which the principle is based are limited to the ability to pause, fast-forward, and rewind the video—hardly what current educational scholarship would describe as "interactive" in any meaningful sense.

We were intrigued by the implications of social agency theory, developed to explain differing engagement of and learning impacts upon a viewer when learning from various forms of a pedagogical agent (Mayer, 2014). This scholarship explored the effects of agents with different qualities, such as including or lacking an audible or visible component, a static versus dynamic visible representation, and animated representations resembling humans and non-human creatures. The theory proposes that social cues received by the learner from the pedagogical agent increase learner motivation to pay attention and make sense of the presented information, and that these motivations increase as the qualities of an on-screen pedagogical agent (e.g. voice, face, mannerisms, behaviour) better resemble those of a real human being. As well, learning is positively impacted if the pedagogical agent is perceived as credible and trustworthy (Schroeder & Adesope, 2014).

At the time, we found that almost all online instructional chemistry videos (e.g. YouTube videos, resources on Khan Academy, and similar sites) were the same style and format. They made no attempt to duplicate an in-person lecture experience, passive or otherwise. Rather, they generally used a screen capture format in which dynamic generation of an instructor's written digital notes, or progress through a digital slideshow, was recorded and accompanied by voiced narration. With the wide availability of tablet computers and recording software, such videos are simple to create, because they require no specialized equipment or sophisticated video-editing skills. However, we felt that such a screencast video format represents a less impactful educational experience than even a traditional passive lecture: such videos offer no truly interactive component beyond the ability to pause or repeat chosen segments, and the instructor presence is reduced only to the disembodied voice of a narrator, contrary to both Mayer's recommendations and the implications of social agency theory.

In contrast, we found publicly-available educational videos from non-academic sources, such as Crash Course (CrashCourse, n.d.), to be far more dynamic, well structured, and engaging. These videos feature the continual on-screen presence of a narrator/instructor, but they do not merely duplicate the experience of a traditional lecture. Instead, they exploit the digital video medium to combine multiple presentation formats and segments within each video, a recognizable structure and graphic design style repeated across multiple videos in each series, and high-quality animations, sound, and editing.

We therefore recognized that while the digital video format offers many potential advantages compared to in-class instruction, most publicly-available instructional videos fail to exploit them fully (Box et al., 2017); to meet that potential would demand careful consideration in scripting and design. Some advantages are inherent to the video format and a flipped-learning delivery. Unlike a live lecture, a video can be paused or have its playback speed manipulated, so

a viewer can speed up, slow down, or repeat video sections according to their own learning pace. A video can include captioning, which is helpful for learners with language challenges or when the content introduces new terminology (Galloway et al., 2017; Taber, 2019). A video can be watched by a learner at the time and place of their own choosing, asynchronously from the schedules of the instructor or other learners (Borup et al., 2012).

However, we identified other advantages that would emerge only if we deliberately chose to incorporate them. In the context of chemistry education, a defining paradigm and well-understood challenge is represented by Johnstone's Triangle (**Figure 12.1**): the learning and understanding of chemistry demands that macroscopic, observable changes be imagined and interpreted by the behaviour of invisible particles at the molecular scale, the nature of which can be represented and expressed only via a specialized symbolic language (Johnstone, 1991).

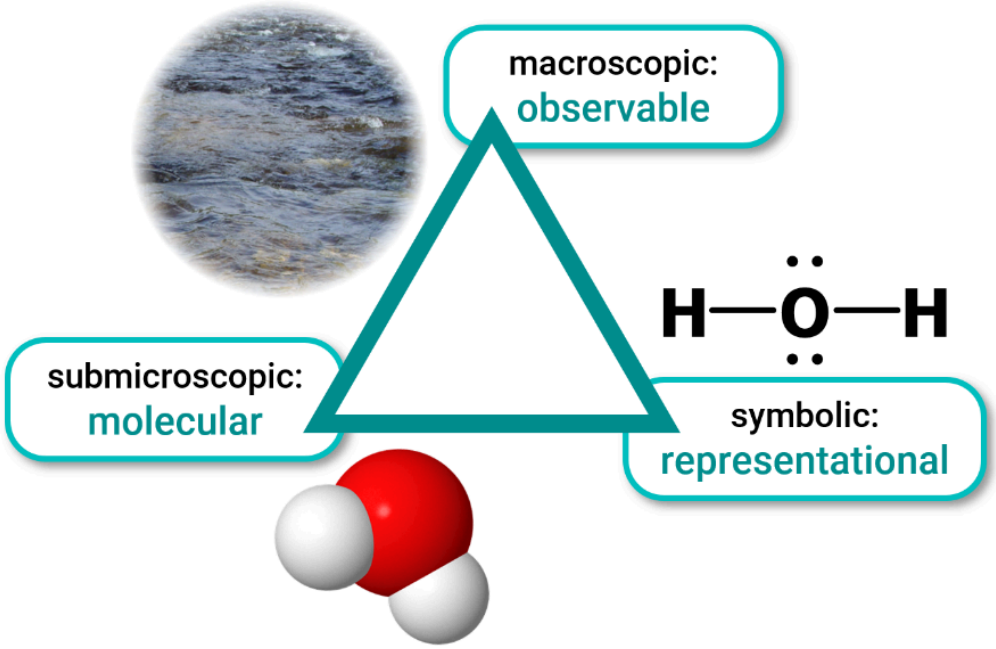

***Figure* 12.1** *Johnstone's Triangle, representing the three levels of interpretation in chemistry: the macroscopic and observable world, molecular-scale particles, and the symbolic representation of those particles (Johnstone, 1991)*

While perhaps not the most effective format for many instructional elements, we felt that a digital tablet screencast would be an excellent format for the symbolic aspects of our videos—the dynamic drawing of molecular structures, reaction equations, graphs, etc.—and the opportunity to repeatedly watch (and mimic) the drawing of such symbols and representations allows the self-directed practice required to gain fluency in the language of chemical symbolism in a way that a live lecture does not. We recognized that a lecture setting renders it challenging to offer direct experimental verification of new concepts, because chemistry experiments visible to all learners in a large lecture space are often impractical. However, a video can transport the viewer to a laboratory setting to observe a macroscopic demonstration of conceptual principles. As well, the molecular-scale dynamic behaviour and interaction of particles is difficult to convey using traditional lecture tools, but a video can use animations to depict such behaviours.

Finally, we had designed a course delivery strategy based on constructivist principles and the positive impacts of the high student engagement found in active learning and small group work. We felt that a single student passively watching a video, interacting with neither an instructor nor other learners, represents the antithesis of those principles; however, we believed that emerging technologies could permit the creation of truly interactive videos that better aligned with our pedagogy.

Guiding Principles for an Instructional Video Series

We therefore understood that we could create instructional videos operating at the intersection of the following guiding principles:

- Adopt principles for effective multimedia learning resources established by the scholarship and research of Mayer and others—particularly regarding those associated with maintaining viewer engagement and the pedagogical effectiveness of an on-screen instructor— but also adapt these principles to more advanced digital video formats.
- Adopt a visual and tonal style reminiscent of video series such as Crash Course, featuring a high-energy instructor figure, cuts and edits to maintain viewer interest and engagement, and a regular sequence of segments shared across all videos in the series.
- Formulate a video structure aligned with the principles of Johnstone's Triangle, featuring different segments corresponding to the macroscopic, molecular, and symbolic representations of chemistry.
- Design instructional videos aligned with the pedagogical principles of the course as a whole by leveraging digital technologies to permit genuine viewer interactivity.

To achieve these goals, we created instructional videos with the following design elements:

- The regular visual presence of an instructor, including their (apparent) interaction with on-screen information, and a high-energy, engaging, and welcoming demeanour.
- Multiple short segments of presentation and summary designed to reduce cognitive load, with different segments within each video patterned after the corners of Johnstone's Triangle: the macroscopic represented by laboratory experiments, the molecular by animations of atoms and molecules, and the symbolic by dynamic on-screen generation of written symbols and molecular structures.
- Interactive questions embedded within each video such that any response by the viewer to a multiple-choice prompt results in targeted feedback from the on-screen instructor, either through a suggestion to guide the viewer away from misconceptions leading to a given incorrect response or through reinforcement and positive feedback to a correct response.
- A consistent structure shared by all videos in the series: a short "cold open" segment in which the instructor provides an introduction and context, a title sequence and card, sequences in which the instructor presents information required to develop each conceptual learning objective followed by an interactive multiple-choice question to assess the achievement of that objective, cut sequences alerting the viewer to each new segment, and a conclusion by the instructor that summarizes the learning outcomes and teases their use in the following classroom activity.
- A characteristic graphical style shared across the video thumbnails, title card, logo, cut and animation sequences, and the outro sequence, including cartoon avatars of the instructor (Figure 12.2).

Development and Implementation of Interactive Instructional Videos

After identifying the learning objectives and course topics for our flipped-learning modules, we generated detailed scripts and storyboards that included our desired design elements and built a small set for the instructor segments. The instructor (**Figure 12.3**) and "To the Lab" segments (**Figure 12.4a**) were recorded using professional-level cameras and audio- recording equipment, graphics and animations for the molecular-scale "Let's Get Small" segments were created using Adobe Illustrator and Adobe After Effects (**Figure 12.4b**), and "The Mighty Pen" screencasts were

generated with Camtasia and a tablet PC (**Figure 12.4c**). Footage from all sources was compiled and edited using Adobe Premiere Pro.[1]

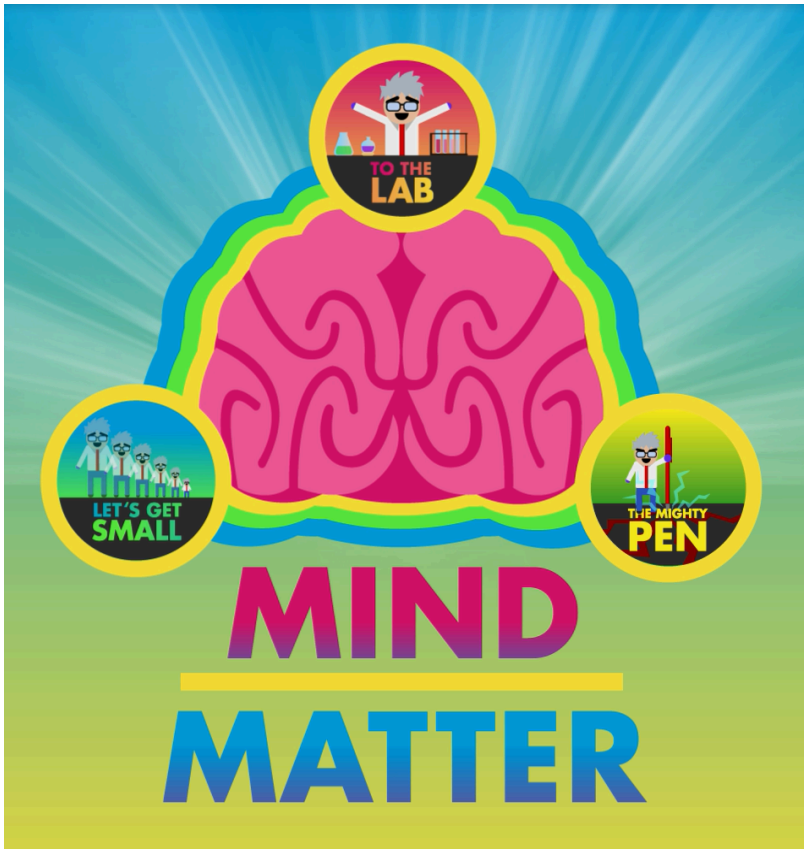

Figure 12.2 *Instructional video title card graphic, including iconography for different video segments, each reflecting a characteristic corner of Johnstone's Triangle.*

Figure 12.3 *The video instructor introducing a topic.*

1. All six videos in the Mind Over Matter series, along with their accompanying flipped-class learning activities, are freely available for use as open educational resources at Undergraduate - Introductory Chemistry Flipped Classroom Modules (via OER Commons).

Figure 12.4 *Example screenshots from different video segments, each corresponding toa corner of Johnstone's Triangle as seen in* ***Figure 12.1*** *and represented by iconography in* ***Figure 12.2****. (a) The instructor carrying out a laboratory experiment (macroscopic observation, "To the Lab"). (b) An animation of molecules colliding (molecular, "Let's Get Small"). (c) Tablet screencast of chemical symbolism (symbolic, "The Mighty Pen").*

To gauge student satisfaction with the first iteration of these instructional videos, and identify particular aspects of the videos that were either perceived favourably or might be improved, we undertook an initial research study (Petillion & McNeil, 2020a). At the end of our two-term first-year chemistry course sequence, 76% of 297 survey respondents reported some level of agreement with the prompt "the instructional videos helped me understand and apply the course concepts." Semi-structured interviews with a small cohort (N = 12) gave participants the opportunity to describe positive and negative learning impacts and experiences with the videos in further detail. Students overall reported that they found the videos to be very useful and engaging learning activities.

However, a large number of less positive responses and explicit suggestions for improvement regarded the manner in which the interactive questions were used and navigated. The videos were initially hosted on YouTube, and the questions and instructor feedback had been designed to use a YouTube annotation feature whereby a viewer could click on a designated region in the video image and navigate to a different timestamp in the same video: that timestamp would play feedback appropriate to the chosen answer, followed by navigation back to the question if that answer was incorrect. During final editing of the videos, YouTube discontinued this feature, requiring us to adopt a cumbersome system of timestamp links placed in the video description box; this system required students to follow additional instructions to select each appropriate link in sequence depending on their chosen answers to a question. Students found this system confusing and disruptive.

To address these concerns, we revised the videos to make use of HTML5 Package ("H5P"), a free open-source JavaScript tool to add interactive HTML5 content to videos, presentations, web pages, and other media via a web-based editor. We used H5P to create multiple interactive questions within each video, with each following a similar sequence. The instructor poses a multiple-choice question to assess understanding of the material just presented, and the video pauses on a screen with different possible answers. When the viewer clicks on an answer, the video jumps to a pre-set timestamp where the instructor reappears on screen to offer targeted feedback: congratulations and a summary of the correct reasoning if the selected answer is correct, or a prompt that identifies the error and offers a hint if the selected answer is incorrect. The video then either continues to play to the next segment or returns the viewer to the question for another attempt. This technology transforms the video into a genuinely active and interactive learning experience, because the viewer receives immediate targeted feedback to assess and develop their understanding of the presented concepts.

Video Assessment and Impacts on Teaching Practice

After the incorporation of H5P interactivity and finalization of the video format, we conducted a more in-depth study to address the following research questions:

When considering various design factors of instructional videos used in a first-year university chemistry course:

1. Which factors of interactive instructional videos do students identify as most significantly contributing to their engagement and their learning?
2. How do student confidences in their learning differ when they learn a topic from videos with different design features? (Petillion & McNeil, 2025)

These were not questions that sought to quantify the learning impacts associated with our video design in an isolated learning intervention, as the videos were already part of our larger course delivery and suite of active learning activities. Rather, we sought an assessment of student perceptions of their learning from the videos and of the specific video design features that students reported as contributing most significantly to their learning and engagement. The focus of our research questions in these studies was grounded in subjective student perspectives and experiences: we therefore adopted an interpretivist paradigm for this study and developed a mixed-methods approach (Johnson & Christensen, 2012; Creswell, 2015) to generate both Likert-scale survey data and interview transcripts that were subjected to thematic analysis via inductive coding (Auerback & Silverstein, 2003). In one component of the study, surveys asked students (N = 488) to rank various video design factors according to their perceived impacts on viewer learning and engagement, while semi-structured interviews (N = 34) prompted participants to describe in greater detail their learning experiences with the videos in relation to specific design features. In a second component, students (N = 24) viewed instructional videos that dealt with the same topic but did so using different combinations of design elements, such as the presence or absence of an on-screen instructor or interactive questions. They were then asked to rate their engagement, learning experiences, and confidence in their ability to solve problems involving an application of concepts developed in the video. The data from these different study components repeatedly and consistently showed two factors as the most important to both student engagement and student learning: the visible on-screen presence of the instructor and the use of interactive questions.

A separate phenomenological research study at the onset of the pandemic in the spring of 2020 explored our students' experiences during the transition to emergency remote teaching (Petillion & McNeil, 2020b). Our students reported that one of their greatest challenges was the loss of meaningful communication and interaction with their instructors and other students and the resulting severe reduction in engagement with their studies. Taken together, the findings from these research studies significantly impacted our decisions about our teaching practice during the following year of online instruction.

For example, in response to our findings that an on-screen instructor presence was a significant factor in promoting viewer learning and engagement, one of the authors (McNeil) ensured their face was always prominently visible in both pre-recorded videos and livestream lectures, by using a webcam feed that placed their live image alongside information elsewhere on screen and allowed them to gesture toward that information. Our studies showed that interactivity was a critical design feature of our videos, so McNeil revised their lecture delivery for online video streaming to incorporate far more regular use of web-based personal response systems so that students could remotely maintain active participation during online lectures. One of the authors (Petillion) delivered an organic chemistry laboratory as a synchronous multi-camera livestream rather than using pre-recorded videos so that the online laboratory session featured a live instructor physically present in the laboratory, with whom students could directly engage and interact. A research study showed that this was an overwhelmingly more positive learning experience (Petillion & McNeil, 2021).

Conclusion

Our development and implementation of instructional videos for our first-year chemistry course sequence, initially undertaken well before the COVID-19 pandemic, began with a critical examination of prior educational

scholarship regarding the recommended design features and best practices for creating instructional videos. This scholarship, and our own studies examining student use of the videos we created, provided us with significant insight regarding the design elements that made such videos engaging and effective, which we then used to improve those same videos. A more in-depth research study clearly identified the most impactful design features.

These were insights that suddenly became of disproportionate importance when our entire teaching practice was moved unexpectedly into an online environment in which nearly all instructional delivery, both synchronous and asynchronous, involved a video component. However, upon further reflection on our experience with online instruction and ongoing scholarship examining best practices of both online and video-based educational resources, we realized there are additional evolving considerations we must contemplate in the design of any future video learning resources, compelling a wider scope of significant questions regarding the format and design of any video-based learning activity or resource (questions we also encourage the reader to consider):

1. What are the implications of existing theoretical frameworks of teaching and learning for the design and format
2. What innovative technologies might be used to improve the learning experience?
3. How can we assess the impacts and effectiveness of a new video learning resource? Is there an opportunity for further scholarship in exploring the design or use of the resource?

For example, the written-notes screen-capture components of our videos were recorded before our own studies demonstrated the high importance of having an on-screen instructor presence; they involve narration but no video representation of the instructor, and we intend to edit these portions to include a video image of the instructor speaking during these sequences. The original development of our videos did not make sufficient use of universal design principles (Burgstahler & Cory, 2008; Hall et al., 2012; Meyer et al., 2014; Navarro et al., 2024), so that, among other concerns, made captioning an after-the-fact consideration and the colour palettes not always colour-blind friendly (Kaspar & Crameri, 2022).

Additionally, our interpretation of our own studies and other scholarship is that the high production value, set design, and near-professional-level equipment and editing we employed in our video series, while appreciated and regarded favourably by most students, likely adds little value in the way of learning impacts. Instead, we believe that similar learning gains and engagement can result from a far simpler video design format, so long as it maintains the presence of an onscreen instructor who interacts with dynamic writing and simple slideshow animations and includes genuinely interactive features, such as those provided by H5P or similar tools. In fact, a small number of participants in our studies preferred such a minimalist format and reported that the cut sequences, bright colours, and animations made it harder for them to maintain focus on their learning. In the future, our instructional video design will focus only on those elements we believe to be most impactful, all of which are easily incorporated using readily available desktop computer systems.

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References

Abraham, M. R. (2005). Inquiry and the l earning cycle approach. In N. J. Pienta, M. M. Cooper, & T. J. Greenbowe (Eds.), *Chemist's guide to effective teaching* (pp. 41–52). Prentice-Hall.

Auerbach , C. F., & Silverstein, L. B. (2003). *Qualitative data: An introduction to coding and analysis*. New York University Press.

Bancroft, S. F., Jalaeian, M., & John, S. R. (2021). Systematic review of flipped instruction in undergraduate chemistry lectures (2007–2019): Facilitation, independent practice, accountability, and measure type matter. *Journal of Chemical Education*, 98(7), 2143–2155. https://doi.org/10.1021/acs.jchemed.0c01327

Biard, N., Cojean, S., & Jamet, E. (2018). Effects of segmentation and pacing on procedural learning by video. *Computers in Human Behavior*, 89, 411–417. https://doi.org/10.1016/j.chb.2017.12.002

Bokosmaty, R., Bridgeman, A., & Muir, M. (2019). Using a partially flipped learning model to teach first year undergraduate chemistry. *Journal of Chemical Education*, 96(4), 629–639. https://doi.org/10.1021/acs.jchemed.8b00414

Borup, J., West, R. E., & Graham, C. R. (2012). Improving online social presence through asynchronous video. *The Internet and Higher Education*, 15(3), 195–203. https://doi.org/10.1016/j.iheduc.2011.11.001

Box, M. C., Dunnagan, C. L., Hirsh, L. A. S., Cherry, C. R., Christianson, K. A., Gibson, R. J., Wolfe, M. I., & Gallardo-Williams, M. T. (2017). Qualitative and quantitative evaluation of three types of student-generated videos as instructional support in organic chemistry laboratories. *Journal of Chemical Education*, 94(2), 164–170. https://doi.org/10.1021/acs.jchemed.6b00451

Burgstahler, S. E., & Cory, R. C. (Eds.). (2008). *Universal design in higher education: From principles to practice*. Harvard Education Press.

Creswell, J. W. (2015). A *concise introduction to mixed methods research*. SAGE.

CrashCourse. (n.d.). *Home* [YouTube Channel]. YouTube. Retrieved Jan 25, 2023, from https://www.youtube.com/@crashcourse

Fiorella, L., & Mayer, R. E. (2018). What works and doesn't work with instructional video. *Computers in Human Behavior*, 89, 465–470. https://doi.org/10.1016/j.chb.2018.07.015

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., & Wenderoth, M. P. (2014). Active learning increases student performance in science, engineering, and mathematics. *Proceedings of the National Academy of Sciences*, 111(23), 8410–8415. https://doi.org/10.1073/pnas.1319030111

Galloway, K. R., Stoyanovich, C., & Flynn, A. B. (2017). Students' interpretations of mechanistic language in organic chemistry before learning reactions. *Chemistry Education Research and Practice*, 18(2), 353–374. https://doi.org/10.1039/C6RP00231E

Gilley, B. H., & Clarkston, B. (2014). Research and teaching: Collaborative testing: Evidence of learning in a controlled in-class study of undergraduate students. *Journal of College Science Teaching*, 43(3). https://doi.org/10.2505/4/jcst14_043_03_83

Hall, T. E., Meyer, A. & Rose, D. H. (Eds.). (2012). *Universal design for learning in the classroom: Practical applications*. Guilford Press.

Johnson, R. B., & Christensen, L. B. (2012). *Educational research: Quantitative, qualitative, and mixed approaches*. SAGE.

Johnstone, A. H. (1991). Why is science difficult to learn? Things are seldom what they seem. *Journal of Computer Assisted Learning*, 7(2), 75–83. https://doi.org/10.1111/j.1365-2729.1991.tb00230.x

Kaspar, F. & Crameri, F. (2022). Coloring chemistry—How mindful color choices improve chemical communication. *Angewendte Chemie International Edition*, 61(16), Article e202114910. https://doi.org/10.1002/anie.202114910

Kukla, A. (2000). *Social constructivism and the philosophy of science*. Routledge.

Kulak, V., & Newton, G. (2014). A guide to using case-based learning in biochemistry education. *Biochemistry and Molecular Biology Education*, 42(6), 457–473. https://doi.org/10.1002/bmb.20823

Liu, Y., Ferrell, B., Barbera, J., & Lewis, J. E. (2017). Development and evaluation of a chemistry-specific version of the academic motivation scale (AMS-Chemistry). *Chemistry Education Research and Practice*, 18(1), 191–213. https://doi.org/10.1039/C6RP00200E

Lundin, M., Rensfeldt, A. B., Hillman, T., Lantz-Andersson, A., & Peterson, L. (2018). Higher education dominance and siloed knowledge: A systematic review of flipped classroom research. *International Journal of Educational Technology in Higher Education*, 15(1), Article 20. https://doi.org/10.1186/s41239-018-0101-6

Mahaffy, P. G., Matlin, S. A., Holme, T. A., & MacKellar, J. (2019). Systems thinking for education about the molecular basis of sustainability. *Nature Sustainability*, 2(5), 362–370. https://doi.org/10.1038/s41893-019-0285-3

Matthews, M. R. (Ed.). (1998). *Constructivism in science education:* A *philosophical examination*. Springer.

Mayer, R. E. (2003). The promise of multimedia learning: Using the same instructional design methods across different media. *Learning and Instruction*, 13(2), 125–139. https://doi.org/10.1016/S0959-4752(02)00016-6

Mayer, R., E. (2014). Principles based on social cues in multimedia learning: Personalization, voice, image, and embodiment principles. In R. E. Mayer (Ed.), *Cambridge handbook of multimedia learning* (2nd ed., pp. 345–368). Cambridge University Press.

Mayer, R. E., Fiorella, L., & Stull, A. (2020). Five ways to increase the effectiveness of instructional video. *Educational Technology Research and Development*, 68(3), 837–852. https://doi.org/10.1007/s11423-020-09749-6

Merkt, M., Weigand, S., Heier, A., & Schwan, S. (2011). Learning with videos vs. learning with print: The role of interactive features. *Learning and Instruction*, 21(6), 687–704 . https://doi.org/10.1016/j.learninstruc.2011.03.004

Meyer, A., Rose, D. H., & Gordon, D. (2014). *Universal design for learning: Theory and practice*. CAST Professional Publishing.

Navarro, N., Corrales, P., Vila-Bedmar, R., González-Montesino, R. H., de Luis, O., & Espada-Chavarria, R. (2024). Development of educational video capsules for active learning in environmental sciences through universal design for learning. *Education Sciences*, 14(8), Article 826. https://doi.org/10.3390/educsci14080826

O'Flaherty, J., & Phillips, C. (2015). The use of flipped classrooms in higher education: A scoping review. *The Internet and Higher Education*, 25, 85–95. https://doi.org/10.1016/j.iheduc.2015.02.002

Orgill, M., York, S., & MacKellar, J. (2019). Introduction to systems thinking for the chemistry education community. *Journal of Chemical Education*, 96(12), 2720–2729. https://doi.org/10.1021/acs.jchemed.9b00169

Petillion, R. J., Freeman, T. K., & McNeil, W. S. (2019). United Nations sustainable development goals as a thematic

framework for an introductory chemistry curriculum. *Journal of Chemical Education*, 96(12), 2845-2851. https://doi.org/10.1021/acs.jchemed.9b00307

Petillion, R. J., & McNeil, W. S. (2020a). Johnstone's triangle as a pedagogical framework for flipped-class instructional videos in introductory chemistry. *Journal of Chemical Education*, 97(6), 1536– 1542. https://doi.org/10.1021/acs.jchemed.9b01105

Petillion, R. J., & McNeil, W. S. (2020b). Student experiences of emergency remote teaching: Impacts of instructor practice on student learning, engagement, and well-being. *Journal of Chemical Education*, 97(9), 2486–2493. https://doi.org/10.1021/acs.jchemed.0c00733

Petillion, R. J., & McNeil, W. S. (2021). Student satisfaction with synchronous online organic chemistry laboratories: Prerecorded video vs livestream. *Journal of Chemical Education*, 98(9), 2861–2869. https://doi.org/10.1021/acs.jchemed.1c00549

Petillion, R. J. & McNeil W. S. (2025). *Exploring student perceptions and learning impacts of design factors for effective and engaging instructional videos* [Manuscript in preparation].

Pritchard, A., & Woollard, J. (2010). *Psychology for the classroom: Constructivism and social learning*. Routledge.

Schroeder, N. L., & Adesope, O. O. (2014). A systematic review of pedagogical agents' persona, motivation, and cognitive load implications for learners. *Journal of Research on Technology in Education*, 46(3), 229–251. https://doi.org/10.1080/15391523.2014.888265

Seery, M. K. (2015). Flipped learning in higher education chemistry: Emerging trends and potential directions. *Chemistry Education Research and Practice*, 16(4), 758–768. https://doi.org/10.1039/C5RP00136F

Smith, J. A. (Ed.). (2008). *Qualitative psychology: A practical guide to research methods*. Sage.

Smith, M. K., Wood, W. B., Krauter, K., & Knight, J. K. (2011). Combining peer discussion with instructor explanation increases student learning from in-class concept questions. *CBE—Life Sciences Education*, 10(1), 55–63. https://doi.org/10.1187/cbe.10-08-0101

Taber, K. S. (2019). Alternative conceptions and the learning of chemistry. *Israel Journal of Chemistry*, 59(6–7), 450–469. https://doi.org/10.1002/ijch.201800046

Talbert, R. (2017). *Flipped l earning: A guide for higher education faculty*. Stylus Publishing.

Terrion, J. L., & Aceti, V. (2012). Perceptions of the effects of clicker technology on student learning and engagement: A study of freshmen chemistry students. *Research in Learning Technology*, 20(2), Article 16150. https://doi.org/10.3402/rlt.v20i0.16150

Theobald, E. J., Hill, M. J., Tran, E., Agrawal, S., Arroyo, E. N., Behling, S., Chambwe, N., Cintrón, D. L., Cooper, J. D., Dunster, G., Grummer, J. A., Hennessey, K., Hsiao, J., Iranon, N., Jones, L., Jordt, H., Keller, M., Lacey, M. E., Littlefield, C. E., … Freeman, S. (2020). Active learning narrows achievement gaps for underrepresented students in undergraduate science, technology, engineering, and math. *Proceedings of the National Academy of Sciences*, 117(12), 6476–6483. https://doi.org/10.1073/pnas.1916903117

Media Attributions

All images in this chapter have been created by the author, unless otherwise noted below.

13. Using an Interactive Online Game Platform for Teaching and Learning

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Introduction

During and since the onslaught of the COVID-19 pandemic, many educational institutions have pivoted to online-based solutions in order to minimize the disruptive impacts of the pandemic—and future major disruptions—on teaching and learning activities (Pokhrel & Chhetri, 2021). While conventional teaching and learning activities, such as those that involve whiteboards and slideshow presentations, could be easily replaced with video conferencing solutions (e.g., ZOOM and MS Teams), the more interactive teaching activities could not be easily replaced by these solutions as they were unable to replicate the natural feel of bodily and gestural interactions. Our course on artificial intelligence in game design was one such course as it could not be easily shifted to any readily available online platforms due to its inherent need for embodied interactions in the teaching and learning process. Therefore, we had to build an in-house interactive online platform that allowed for the replication of embodied interactions in the online space; we named this platform CAVRoom, after our laboratory name—the Centre for Augmented and Virtual Reality.

In this chapter, we will use the Community of Inquiry (COI) framework to guide our reflection on how social, cognitive, and teaching presence was afforded in the use of our in-house developed online interactive game platform—CAVRoom—to teach the concepts of mechanics, design, and aesthetics (MDA) (Hunicke et al., 2004) in the Artificial Intelligence in Game Design course that was led and taught by the third author. This was a graduate elective course in the Nanyang Technological University's School of Computer Science and Engineering. This course's main learning outcome was to equip students with the ability to design games to simulate science/engineering problems. The average cohort size was 30–40 students, and MDA was the first topic in this one-semester long course. This session was run in a workshop format led by the third author with the technical assistance and support from the second author, who was, at the time, a post-doc staff working with the first author. In preparing this chapter, the first author collaborated with the two authors in their retrospective reflection on the pedagogical effectiveness of the lesson.

Literature Review

Teaching and Learning in the Online Space

As an emergency response to the sudden shutdown of face-to-face teaching in the first quarter of 2020, many educators around the world had to quickly shift their teaching to the online space (Meinck et al., 2022). Readily available platforms—such as learning management systems (e.g., Canvas, Blackboard), video conferencing platforms (e.g., Zoom, Skype), collaboration platforms (e.g., Microsoft Teams), and educational suites (e.g., Google Classroom)—quickly became a first option for many (Saha et al., 2022). While these online venues made the continuity of education provision possible in such a difficult time, teaching and learning in this digital space (particularly when conducted asynchronously) has frequently been associated with many limitations, such as lack of motivation (Huang & Wang, 2022), engagement

(Hollister et al., 2022), and interaction (Baczek et al., 2021) as well as feelings of isolation (Wilczewski et al., 2021), which eventually led to a decrease in academic performance in many cases (Engzell et al., 2021). Compared to face-to-face learning, online learning seems to be less engaging for many students, particularly when it comes to collaboration, student-teacher interactions, and peer discussions (Beckwith, 2020), and more so in the asynchronous mode (Beckwith, 2020). In many cases, this is attributable to the lack of a sense of community in this mode of learning (Chatterjee & Correia, 2020).

Given the direct correlation between students' engagement and academic performance (Lei et al., 2018), it is essential to create a sense of community in online learning. Our in-house platform—CAVRoom—afforded such a sense of community through social, cognitive, and teaching presence, from a transformative paradigm.

Community of Inquiry

The COI framework is perhaps one of the most relevant approaches to understanding the mechanisms of online learning. Originally developed as a method to understand computer-mediated communication (Garrison et al., 1999), the COI framework is grounded in collaborative constructivism and offers a structured approach to understanding the impact of learning environments on the cognitive processes of the participants (Garrison, 2015).

The COI framework is tripartite, comprising cognitive, social, and teaching presence. The first element, cognitive presence, refers to the extent of the participants' ability in making meaning and constructing knowledge through the discourse shared by the critical community of inquiry. Operationalized as a four-stage model of Practical Inquiry (PI)—which is a recursive process of exploration, integration, and resolution in critical thinking and meaning construction (Garrison et al., 2001)—cognitive presence is often considered as the most fundamental to academic success but is also likely the most difficult one to achieve in online learning (Garrison & Arbaugh, 2007).

Similarly, social presence is another challenging aspect of online learning. This second element of the COI framework refers to the sense of belonging resulting from identifying and communicating with the group and developing personal/emotional relationship through imbuing an online persona with the real person's characteristics (Garrison, 2016). As the most researched element of the three in the COI framework, social presence has been shown to have a strong correlation with learning outcomes and learners' satisfaction (Guo et al., 2021; Hostetter & Busch, 2013).

However, the extent of this correlation is mediated by instructor facilitation (d'Alessio et al., 2019), which is the third element of the COI framework, i.e., the teaching presence. Teaching presence consists of three dimensions of teacher responsibilities: instructional design and organization, discourse facilitation, and direct instruction. It is the bridge between the first and second elements of this framework, and the key to a successful COI (Garrison, 2016).

The COI framework aligns with our transformative research paradigm, as this framework's co-construction of meaning in knowledge formation is epistemologically central in this framework and the multifaceted realities of classroom experience is co-constructed by both teachers and learners as the participants in this collaborative process.

Gamification and Embodied Learning

Identified as innovative pedagogy in Paniagua and Istance (2018), both gamification and embodied learning are often used in education to enhance students' learning experience. Gamification refers to the integration of game elements and principles into educational contexts to make learning more interactive and enjoyable for students, thus fostering a deeper understanding of the material (Dichev & Dicheva, 2017). In a meta-analysis conducted by Sailer and

Homner (2020), gamification in learning is shown to have impacts on cognitive, motivational, and behavioural learning outcomes. In particular, it correlates positively with students' engagement (Hamari et al., 2016) and contributes to students' social, cognitive, and teaching presence development in the online learning space (KiliÇ, 2023).

Similarly, embodied learning is shown to strengthen the sense of social presence , which helps students overcome feelings of isolation in online learning (Chen, 2022). Embodied learning involves active participation and physical engagement in the learning process, allowing students to experience concepts through movement and sensory activities. This approach emphasizes the connection between body and mind, facilitating a holistic understanding of the material. Proponents of this pedagogy argue that due to the embodied nature of cognition, using bodily movements in learning allows for the creation of multimodal representations of sensorimotor experience in the brain, which enhances understanding and facilitates learning (Shapiro & Stolz, 2019). Hence, embodied learning is frequently used as a powerful pedagogy to strengthen cognitive presence.

Our Innovative Solution: CAVRoom

CAVRoom is an in-house developed sandbox card gaming online platform, which allows multiple players to have the freedom to manipulate playing cards together. In this course, we developed CAVRoom based on the Heart Attack game's rules (see Lim, 2017 for an example of this game).

Rationale of the Innovation

Concepts such as the mechanics-dynamics-aesthetics (MDA) of games need to be taught through playing the real game, without which a practical understanding of these concepts is difficult to achieve. Before the pandemic, these games, such as the Heart Attack card game (which is a fast-paced game where players must use a bodily response—i.e., to slap the dealt card—when the number shown on the card corresponds to the running count), took place in face-to-face settings where students played in groups. They played several rounds of this game until they became familiar with the game rules before proceeding to analyse the MDA of the game. They then played a variant of this game where the rules were modified. After this second variant of the gameplay, they proceeded to analyse the MDA of this variant and discuss the differences between these two versions of the game. Through these two variations of the game, students were then able to understand the application of the MDA concepts and appreciate their importance in game design.

When the pandemic hit, we had to move our classes online, in line with the restrictions introduced in response to the pandemic (Ng, 2021). Considering the nature of interactions in the game simulations, we quickly agreed that we were unable to achieve the desired interactions in readily available platforms such as ZOOM, as these platforms were quite limited in terms of enabling physical-digital component relationships, despite their efforts in improving natural interactions through features like video annotation (Domova et al., 2014) and gestures (Amores et al., 2015). Therefore, we built our own platform, CAVRoom, which could mimic the real-life game simulations and hence was able to address the sudden change in teaching modes in response to the pandemic.

Description of the Innovation

CAVRoom is an innovative solution that will enhance the teaching and learning process in the digital space through more natural interaction (Tandianus et al., 2021). The innovative aspects of CAVRoom include the following:

1. **Strong link between physical-digital components:** We built CAVRoom in such a way as to maintain the physical actions that students would do in real-world gameplay as much as possible and keep a straightforward and direct correspondence between physical actions in the real world and digital actions in our CAVRoom. For instance, players can use a touchscreen (or their mouse) to manipulate cards, such as by picking up, moving, or flipping them In the physical version of the game, the players are required to touch their foreheads before slapping the card—in CAVRoom, it is replaced with clicking the bell button on the right-hand side of the screen.
2. **Configurability:** CAVRoom is a virtual reality (VR) platform that can be configured to non-immersive modes (i.e., to be experienced without a VR headset, such as on a conventional monitor) as well as immersive modes (i.e., to be experienced with a VR headset). For its use in the Artificial Intelligence in Game Design course reported in this chapter, CAVRoom was configured to be in the non-immersive mode as the cards in the game being played in this course were thin and flat objects for which a 3D immersive version did not add value to the intended learning.
3. **Sandbox:** In most existing card games (e.g., Solitaire, FreeCell), the possible interactions are hardcoded, i.e., the users can only put the cards in predefined zones. In CAVRoom, however, the players have the freedom to place the cards anywhere on the virtual table. Due to this sandbox characteristic, CAVRoom can be used for various card game activities beyond the Heart Attack game. Moreover, CAVRoom can be easily extended to other disciplines as the cards can be easily used as a proxy for anything. For instance, CAVRoom can be used to teach human anatomy, where each card can represent a 3D human organ, etc.
4. **Platform-agnostic:** CAVRoom is a highly accessible system as it supports various platforms—including Windows, MacOS, Android, and iOS devices—thanks to the versatility of the tool we used to develop it. By being able to run it across multiple platforms, we minimize the possibility of students being left out due to not owning a compatible device, hence ensuring inclusivity. CAVRoom allows users from multiple platforms to share the same virtual space and manipulate the virtual objects in the virtual space, regardless of which platforms they join in from (see **Figure 13.1**), which promotes social presence.

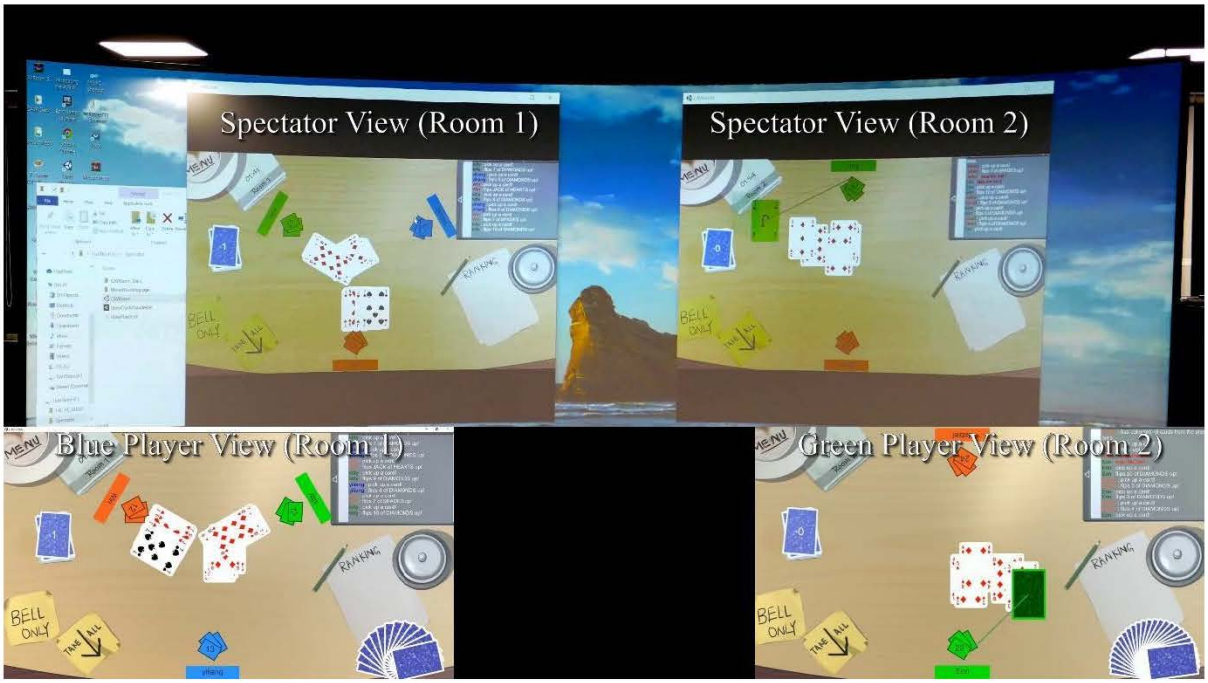

Figure 13.1 *CAVRoom in-session view. A two-room session is running in CAVRoom. The spectator (top) uses a large display and MS Windows platform to view two rooms. Bottom left shows the view of a player using MS Windows in Room 1 and bottom right the view of a player using an Android tablet in Room 2.*

Reflection

In this chapter, we use the COI framework to reflect on our experience, which we collected through a semi-structured interview conversation between the instructor and the authorial team of this chapter, in delivering the lesson on MDA through CAVRoom. We will also discuss the instructor's perceived ease of lesson delivery through this platform and the challenges we faced in the implementation of this CAVRoom-based workshop.

Social, Cognitive, and Teaching Presence

Prior to the pandemic, this session of the class had always been well received by students, who noted that the session was interesting and engaging, due to the interactivity in the immersive gameplay experience that offered social presence through the group cohesion and communication in the gameplay. In teaching this class during the pandemic, where social presence was severely impacted by the physical restrictions imposed by the COVID-19 regulations, we leveraged the technological affordances through the ability to replicate the physical and bodily interactions (for example, the action of slapping the card was replaced by the action of hitting a button) in CAVRoom. Students logged into CAVRoom from their homes, joined a game room, and played the card game with their classmates. During the gameplay, they interacted with each other through the chat function in CAVRoom as well as the voice call (which ran simultaneously via Zoom). This created a sense of social presence for the students.

During the gameplay in CAVRoom, students engaged with the game cognitively and physically through embodied actions, such as dealing the cards, hitting the bell, etc. These embodied actions were designed such that the students learned the MDA concepts in action through this embodied learning. For example, they needed to slap the

dealt card by hitting the bell button on the right-hand side (see **Figure 13.1**). Such an embodied action was part of the aesthetics of the game, which is component A of the MDA concepts. Through embodied learning, which we successfully moved to CAVRoom, students experienced cognitive presence while learning the MDA concepts.

Through CAVRoom, students experienced not only the social presence in the group dynamics during the gameplay and cognitive presence through experiencing the MDA concepts in action but also teaching presence through the monitoring of the gameplay in real-time by the instructor, which would have otherwise been difficult due to the non-physical lesson setting. In fact, one main advantage of the use of CAVRoom in this lesson was the strengthening of teaching presence. In using CAVRoom, the instructor was able to monitor (or even record, for review purposes) the whole class owing to the availability of a spectator mode option in CAVRoom as well as the use of a large display to project all virtual rooms at once (see **Figure 13.2**). Such simultaneous attention was not possible in the physical class setting, where the instructor had to go around the groups in the class to monitor their gameplay. However, with the use of CAVRoom, which was projected onto a large display, the instructor was able to view all groups at once. Students were also able to ask questions when the instructor entered/joined their virtual rooms. This strengthened the teaching presence in our online CAVRoom class. Students expressed positive feelings toward their learning experience in CAVRoom, noting that they were thankful to have had CAVRoom as an alternative avenue that enabled them to play the card game online, which they would otherwise have missed out on.

Figure 13.2 *Instructor's view of CAVRoom class session in-progress. Each group of students was placed in a separate virtual space/room and the instructor was monitoring the four game rooms through a large screen of 8.8 m x 2.6 m in size.*

Instructor's Perceived Ease of Lesson Delivery

We did not notice much difference between the face-to-face class and the online class via CAVRoom in terms of the ease of lesson delivery. In retrospect, we reckoned this was because the students had had a semester of experience with online learning by the time our class was in-session. Students would have been familiar with digital platforms and the norms of online learning. In delivering our lesson, we noticed that students brought over their prior knowledge of digital platforms and seamlessly applied it in our class. Students were able to interact with their peers and with the instructor. In the class discussion following the gameplay, the instructor was able to elicit students' responses that prompted them to connect their gameplay experience in CAVRoom with the key concepts in the lesson, engaging students cognitively in their learning. Similar to any Zoom lectures/tutorials, we also experienced slight time lags in students' responses, but this did not impact the class progress. Hence, in our reflection, we did not note any significant problems in the ease of lesson delivery. One caveat we would like to note is that when we ran this CAVRoom lesson for the first time, we required assistance from our research assistants to set up the network and get the platform and display ready. We believe that with further improvements, CAVRoom could be more user-friendly and take less technical skills to set up when running it for the first time.

Challenges in Implementation

In terms of the implementation of our platform, we noticed a small hiccup. While the procedure on how to connect to the platform was given to the students prior to the day of the class session, the actual game was only unveiled at the beginning of the session for the pedagogical rationale of gauging the students' spontaneity while playing the game without prior preparation. Therefore, the students would have not been very familiar with the game interface prior to the class session. On the day of the class, we noticed that students took time to get familiar with the user interface of the platform. For example, it took them a few minutes to work out which button on their keyboard corresponded to which function in the platform, etc. In retrospect, this could partially be due to the rather rudimentary design in this first version of CAVRoom, which was put together rather hurriedly as an emergency response to the need for online teaching in the pandemic. We believe that a more polished version of CAVRoom could improve the user interface design (for example, through a more intuitive button-function correspondence) and offer a smoother experience for students.

Conclusion

We contend that CAVRoom, which was started as an 'emergency response to educational disruption,' mitigated the impacts of the sudden change to the online mode on students' learning. This platform afforded and facilitated a community of inquiry for our students. It provided them with a venue for social presence through the online synchronous team interaction, for cognitive presence through embodied learning in the gameplay within this platform, and for teaching presence through the simultaneous monitoring of the gameplay as well as the live discussion in the workshop. Given the characteristics of the modern-day digital-native generations of students, we are optimistic that our digital and online platform, CAVRoom, has good potential to be further refined to suit post-pandemic education.

Reflective Questions

We invite interested colleagues to consider several questions when thinking about implementing a similar platform like ours into their teaching and to make necessary adjustments:

- What evidence would you need or use to justify the time and expense of creating a specialized technology tool for your course?
- How do you prepare students for the use of new educational technology? What technical or pedagogical supports should be included for students or instructors?
- How could you use the Community of Inquiry framework in an educational technology study, and what features of the educational technology are needed to support social, cognitive, and teaching presence?
- How might tools like artificial intelligence (AI) be utilized to support gameplay monitoring and ease the instructor's cognitive workload during the process?

References

Amores, J., Benavides, X., & Maes, P. (2015). ShowMe: A remote collaboration system that supports immersive gestural communication. In *Proceedings of the 3rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems* (pp. 1343–1348). Association for Computing Machinery. https://doi.org/10.1145/2702613.2732927

Baczek, M., Zaganczyk-Baczek, M., Szpringer, M., Jaroszynski, A., & Wozakowska-Kaplon, B. (2021). Students' perception of online learning during the COVID-19 pandemic: A survey study of Polish medical students. *Medicine*, *100*(7), Article e24821. https://doi.org/10.1097/md.0000000000024821

Beckwith, E. G. (2020). The importance of synchronous sessions in online asynchronous classes. In C. M. Sistek-Chandler (Ed.), *Exploring online learning through synchronous and asynchronous instructional methods* (pp. 34–51). IGI Global. https://doi.org/10.4018/978-1-7998-1622-5.ch002

Chatterjee, R., & Correia, A-P. (2020). Online students' attitudes toward collaborative learning and sense of community. *American Journal of Distance Education*, 34(1), 53–68. https://doi.org/10.1080/08923647.2020.1703479

Chen, X. (2022). The influences of embodied experience on social presence of Chinese university students' online learning. In Z. Zhan, F. P., Chew, & M. T. Anthony (Eds.), *Proceedings of the 2022 International Conference on Science Education and Art Appreciation* (Vol. 675, pp. 96–106). Atlantis Press. https://doi.org/10.2991/978-2-494069-05-3_13

d'Alessio, M. A., Lundquist, L. L., Schwartz, J. J., Pedone, V., Pavia, J., & Fleck, J. (2019). Social presence enhances student performance in an online geology course but depends on instructor facilitation. *Journal of Geoscience Education*, 67(3), 222–236. https://doi.org/10.1080/10899995.2019.1580179

Dichev, C., & Dicheva, D. (2017). Gamifying education: What is known, what is believed and what remains uncertain: A critical review. *International Journal of Educational Technology in Higher Education*, 14(9). https://doi.org/10.1186/s41239-017-0042-5

Domova, V., Vartiainen, E., & Englund, M. (2014). Designing a remote video collaboration system for industrial settings. In *Proceedings of the Ninth ACM International Conference on Interactive Tabletops and Surfaces* (pp. 229–238). Association for Computing Machinery. https://doi.org/10.1145/2669485.2669517

Engzell, P., Frey, A., & Verhagen, M. D. (2021). Learning loss due to school closures during the COVID-19 pandemic. *Proceedings of the National Academy of Sciences*, 118(17), Article e2022376118. https://doi.org/10.1073/pnas.2022376118

Garrison, D. R. (2015). *Thinking collaboratively: Learning in a community of inquiry*. Routledge.

Garrison, D. R. (2016). *E-learning in the 21st century: A community of inquiry framework for research and practice* (3rd ed.). Routledge.

Garrison, D. R., Anderson, T., & Archer, W. (1999). Critical inquiry in a text-based environment: Computer conferencing in higher education. *The Internet and Higher Education*, 2(2–3), 87–105. https://doi.org/10.1016/S1096-7516(00)00016-6

Garrison, D. R., Anderson, T., & Archer, W. (2001). Critical thinking, cognitive presence, and computer conferencing in distance education. *American Journal of Distance Education*, 15(1), 7–23. https://doi.org/10.1080/08923640109527071

Garrison, D. R., & Arbaugh, J. B. (2007). Researching the community of inquiry framework: Review, issues, and future directions. *The Internet and Higher Education*, 10(3), 157– 172. https://doi.org/10.1016/j.iheduc.2007.04.001

Guo, P., Saab, N., Wu, L., & Admiraal, W. (2021). The community of inquiry perspective on students' social presence, cognitive presence, and academic performance in online project-based learning. *Journal of Computer Assisted Learning*, 37(5), 1479–1493. https://doi.org/10.1111/jcal.12586

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in Human Behavior*, 54, 170–179. https://doi.org/10.1016/j.chb.2015.07.045

Hollister, B., Nair, P., Hill-Lindsay, S., & Chukoskie, L. (2022). Engagement in online learning: Student attitudes and behavior during COVID-19. *Frontiers in Education*, 7, Article 851019. https://doi.org/10.3389/feduc.2022.851019

Hostetter, C., & Busch, M. (2013). Community matters: Social presence and learning outcomes. Journal of the *Scholarship of Teaching and Learning*, 13(1), 77–86. https://scholarworks.iu.edu/journals/index.php/josotl/article/view/3268

Huang, Y., & Wang, S. (2022). How to motivate student engagement in emergency online learning? Evidence from the COVID-19 situation. *Higher Education*, 85, 1101–1123 https://doi.org/10.1007/s10734-022-00880-2

Hunicke, R., LeBlanc, M., & Zubek, R. (2004). MDA: A formal approach to game design and game research. In *Proceedings of AAAI Workshop on Challenges in Game AI*, 4(1), 1722.

KiliÇ, S. (2023). Effectiveness of gamification on the community of inquiry development in online project-based programming courses conducted on Facebook. *Informatics in Education*, 22(1), 21–44. https://doi.org/10.15388/infedu.2023.04

Lei, H., Cui, Y., & Zhou, W. (2018). Relationships between student engagement and academic achievement: A meta-analysis. *Social Behavior and Personality: An International Journal*, 46(3), 517–528. https://doi.org/10.2224/sbp.7054

Lim, D. (2017). ♂♂♂♂♂♂♂♂♂♂♂♂ *Heart attack game* [Video]. YouTube. https://youtu.be/N7kG_HHw5io?si=bACwBDhqBjLQyLr7

Meinck, S., Fraillon, J., & Strietholt, R. (Eds.). (2022). *The impact of the COVID-19 pandemic on education: international*

evidence from the Responses to Educational Disruption Survey (REDS). United Nations Educational, Scientific and Cultural Organization. https://unesdoc.unesco.org/ark:/48223/pf0000380398.locale=en

Ng, P. T. (2021). Timely change and timeless constants: COVID-19 and educational change in Singapore. *Educational Research for Policy and Practice*, 20, 19–27. https://doi.org/10.1007/s10671-020-09285-3

Paniagua, A., & Istance, D. (2018). *Teachers as designers of learning environments: The importance of innovative pedagogies*. OECD Publishing. https://doi.org/10.1787/9789264085374-en

Pokhrel, S., & Chhetri, R. (2021). A literature review on impact of COVID-19 pandemic on teaching and learning. *Higher Education for the Future*, 8(1), 133–141. https://doi.org/10.1177/2347631120983481

Saha, S. M., Pranty, S. A., Rana, M. J., Islam, M. J., & Hossain, M. E. (2022). Teaching during a pandemic: do university teachers prefer online teaching? *Heliyon*, 8(1), Article e08663. https://doi.org/10.1016/j.heliyon.2021.e08663

Sailer, M., & Homner, L. (2020). The gamification of learning: A meta-analysis. *Educational Psychology Review*, 32, 77–112. https://doi.org/10.1007/s10648-019-09498-w

Shapiro, L., & Stolz, S. A. (2019). Embodied cognition and its significance for education. *Theory and Research in Education*, 17(1), 19–39. https://doi.org/10.1177/1477878518822149

Tandianus, B., Seah, H. S., Ng, K. T., Sim, D., & Yeap, Y. W. (2021). CAVRoom: Scalable online multiplayer and multiplatform sandbox. In Nakajima, M., Kim, J-G., Lie, W-N., & Kemao, Q. (Eds.), *International Workshop on Advanced Imaging Technology* (Vol. 11766). SPIE. https://doi.org/10.1117/12.2590204

Wilczewski, M., Gorbaniuk, O., & Giuri, P. (2021). The psychological and academic effects of studying from the home and host country during the COVID-19 pandemic. *Frontiers in Psychology*, 12, Article 644096. https://doi.org/10.3389/fpsyg.2021.644096

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14. Statistically Significant: Reflecting on the use of Educational Technology in Online Introductory Statistics Courses

RACHAEL LEWITZKY

Introduction

The field of statistics has always held a special place in my heart. When discussing programs of study with students, colleagues, friends, and family members, each individual is able to recall a story related to an introductory statistics course, working with data, or exploring data literacy. These stories often begin with comments about the relationship between mathematics and statistics and a fear of delving into computations and calculations. Yet, in many cases, these conversations expose revelations about the interdisciplinary nature of statistics and how it requires a synthesis of skills to interpret the meaning of data. The ubiquitous nature of statistics courses in post-secondary programs—regardless of discipline—drew me to the SoTL in such environments. More specifically, I focused on how introductory statistics courses could be offered in online spaces. I wondered:

- How do instructors design and facilitate courses that are often meant to be an entry point for students to the world of data literacy and research?
- How do instructors weave together pedagogy, content, and technology in a virtual setting?
- How do instructors approach challenges in online spaces?

Technology in Online Statistics Classes

Gould (2010) argues that statistics and technology are inseparable. While there are various definitions of what technology means in the context of statistics education (e.g., statistical programming languages, databases, data access and manipulation, visualization tools, and simulations), it has become clear that there is a need to meaningfully utilize technology within statistics courses (Nolan & Lang, 2010).

Before an instructor incorporates technology into a statistics course, students should be provided with concrete examples of how the tool is being used and the underlying mechanisms of the tool. Garfield et al. (2015) note that without such examples, students may lack statistical understanding of particular concepts or they may not believe the results produced by the tool. They explain:

> The thought is that software tools allow students to be directly involved with "building up" the sampling distribution and allowing them to focus on the process involved and therefore on key ideas, rather than simply being presented with the formal end result. (Garfield et al., 2015, p. 335)

Furthermore, it is important for instructors to ensure that technology is scaffolded in their classes to ensure that students have a foundation on which to build their technological understanding.

In order to incorporate technology into statistics courses, many questions must be considered, including how

students will engage with statistical technology throughout the course and once the course is finished. To help meet the diverse needs of students with regard to statistical technology, McNamara (2015) suggests that the technological tools used in statistics courses should have multiple entry points. As noted by Gould et al. (2017), technological tools in statistics should "strive to provide easy entry for new users while still allowing the flexibility to build extensions onto the system, support a cycle of exploratory and confirmatory analysis, promote interactivity, and make it simple to publish and reproduce analysis" (p. 465). Furthermore, students should be able to use the technology as novices and have the opportunity to explore the technology more thoroughly as they become more experienced users.

Building on previous literature that has focused on student retention, completion, and achievement in online statistics courses, this research explores how instructors design, develop, and facilitate online undergraduate introductory statistics courses. With specific reference to teaching statistics, Tishkovskaya and Lancaster (2010) call for an educational reform: "leading statistics educators formulated difficulties in learning statistics, raising issues of concern in statistical education, and urged a reform of statistics instruction and curriculum based on strong synergies among content, pedagogy, and technology" (p. 1). This study, then, aims to investigate the following research questions:

1. How is technology used in online introductory statistics courses?
2. What types of technology are used in online introductory statistics courses?

Methodology

The approach used to conduct this research was a case study using a qualitative empirical methodology. This approach was selected because it allowed me to develop an in-depth understanding of a particular experience (Creswell, 2013; Yeo et al., 2023). Further, Merriam (2009) and Mill et al. (2010) assert that a case study approach is appropriate when the objective of the study is to construct both meaning and understanding. Within the case study, two types of data were collected and examined: semi-structured interviews and course materials (e.g., course syllabus, assignments).

Data Collection

Participants in this research included four instructors (James, John, Lyla, and Greg) who have taught an introductory statistics course online to undergraduate students at a specific university in southern Ontario. The bounded constraints of the case study included the location, the level and type of course being taught (introductory statistics), and the modality of the course (online).

Multiple sources were used to gather evidence during this study. The first data type was semi-structured interviews. Interview questions were organized into subsections, including background questions and questions that aligned with the technology, pedagogy, and content knowledge (TPACK; Mishra & Koehler, 2006) framework. All interviews were recorded and transcribed. Once the interviews were transcribed, a copy of the transcript was shared with the interviewee (member checking) to ensure the information was accurately captured (Birt et al., 2016).

In addition to conducting interviews, course content was examined. The primary document that was investigated in each course was the syllabus. As with the interviews, the TPACK model was used as a lens to explore the experience of teaching statistics online. The purpose of using course content as evidence was to capture the experience of teaching an online statistics course more holistically. Further, evidence presented during interviews was compared and contrasted to how the online course was facilitated.

Data Analysis

Data analysis happened as data was being collected to help guide the follow-up semi-structured interviews (Creswell, 2015). Data was transcribed and coded as interviews proceeded. This allowed me to conduct a constant comparison analysis of all data as it was collected (Leech & Onwuegbuzie, 2011). The purpose of concurrently collecting and analyzing data was to explore the experience until saturation was reached and inform adjustments that should be made to the data gathering (e.g., interview questions, course content analysis).

Determining when a sufficient amount of evidence was collected included considering the themes that emerged within the data. Data was coded in the NVivo 12 software using a combination of deductive and inductive coding informed by the TPACK model.

Lessons Learned About the Relationship Between Online Statistics Courses and Technology

While James, John, Lyla, and Greg used technology in ways that support their learners and teaching philosophies, there are some common themes among how the instructors incorporate technology in their courses. Specifically, the conversations about the use of technology in their online statistics courses centred around multimodal representation, communication, and the mechanics of calculations.

Multimodal Representation

The instructors used both synchronous and asynchronous delivery modes for their courses. James facilitated his course completely asynchronously. His rationale for using this approach was to allow students to progress through the course at their own pace. While he provided them with due dates for evaluation pieces and a recommended schedule, students were responsible for learning the material. This follows his teaching philosophy of treating students like adults and giving them autonomy with their learning. Meanwhile, John, Greg, and Lyla used asynchronous elements in their courses to catch up on material and to provide additional content for optional exploration.

Greg, John, and Lyla all incorporated live, synchronous class time in their courses. Both John and Greg received positive feedback from students for hosting live classes. They credited this success partially due to how they purposefully used asynchronous and synchronous elements in their courses. Greg described how live classes helped mimic the live theatre atmosphere of teaching on campus. Further, he felt that taking this approach to teaching allowed for more authentic learning to take place. He specifically used the example of wanting to be able to work through a problem with students in live-time and follow their directions, rather than using pre-designed slides and revealing the answer immediately. In accordance with Mills and Raju (2011), Greg and John found that facilitating synchronous conversations supported learner-instructor interactions.

Because Lyla designed her course following a flipped-classroom model, she reserved synchronous class time for activities and discussions. She developed videos for students to watch before class and had tasks designed for in-class discussion. When she implemented this teaching approach in her online course, she faced resistance from students. She explained that students felt double the workload, since they had to attend a synchronous class and review content outside of class. Given that her course was a first-year course, students may have resisted this model in part due to motivation and ability to self-direct learning. Farmus et al. (2020) explain that the success of a flipped-classroom model

relies on the idea that "students are motivated enough to 'self-pace' their lecture viewing" (p. 316). Lyla noted that, if she were to offer the course online again, she would either use a purely asynchronous model or synchronous model to avoid student confusion and frustration.

Regardless of whether they facilitated their course using a synchronous or asynchronous approach, each of the participants underscored the importance of recording their material and making content available for students to access at their own convenience. John felt that teaching online lends itself well to allowing students to review content at their own pace. In agreement with Conrad and Openo (2018), Greg, Lyla, and James also noted that the benefit of online learning is that students can access content at their own convenience. Moreover, the participants leveraged the online learning environment to ensure students could access and review learning resources as they pleased.

In addition to discussing their selection of course modality, the participants highlighted the use of various mediums to present statistical concepts. Employing their knowledge of pedagogy and technology, James, Lyla, and John designed short videos for students that focused on specific concepts. Each of these instructors noted that they limited the length of the videos, since they wanted to be concise and keep the students' attention. James believed it was essential to give students choice with regard to how they engage with material—whether that be reading text or watching videos. Each of the instructors also used additional resources, such as textbooks (Lyla, John, and Greg) or self-authored resources (James), to provide students with alternative explanations of concepts.

Finally, the instructors integrated scenarios in their class that replicated evaluation situations. For example, John and Lyla would review prior tests and exams so that students had an idea of what types of questions to expect. They felt students appreciated these review sessions, since they were able to better understand what was expected on assessment pieces. Similarly, Lyla would ask interactive questions during her live lectures using a program called Top Hat. She believed these questions provided students with an opportunity to engage in low-stakes assessments so they could build their confidence when faced with statistical concepts. Greg also designed lectures so that students could respond to questions that were similar to the assignment questions. He felt that giving students the opportunity to guide solutions helped to clarify misconceptions and helped them to develop their communication and statistical thinking skills.

Communication

The participants drew on both their pedagogical knowledge and technological knowledge to facilitate communication channels using technology between themselves and their students as well as among students. Lyla, Greg, and John used Zoom to host their live synchronous lectures as well as their office hours. Though Mills and Raju (2011) suggest that delivering a course synchronously can support learner-instructor interactions, the participants discussed the challenges of offering synchronous courses with large enrollment numbers. They pointed out that it was difficult to note body language and visual cues that students understood the material, since students did not always have their cameras on and it was impossible to see everyone on one screen.

With regard to communicating with students, the participants identified technology as a way to provide students with feedback. Due to the large class sizes, the instructors found it difficult to provide personalized feedback. Though James, Greg, and John used Crowdmark for handwritten assignments, there were limited TA resources to provide individualized instruction. The challenge of providing students with unique feedback on major assignments is in line with comments made by Conrad and Openo (2018) and Figueroa-Cañas and Sancho-Vinuesa (2018). Moreover, the instructors explained that they use class time as an opportunity to provide general feedback, answer commonly asked questions, and clarify misconceptions. That being said, the participants often made use of auto-generated feedback for tasks graded electronically, such as quizzes in the LMS, Maple TA assignments, and online tests.

To provide opportunities for more personalized feedback and one-on-one learning experiences, many of the participants offered virtual office hours. However, that required students to take initiative and seek out feedback and additional help. The participants felt that virtual office hours were used very infrequently and less than during on-campus learning. Nevertheless, the instructors highlighted the satisfaction students had when they did choose to attend virtual office hours. For example, Lyla discussed how students would sometimes attend virtual office hours in small groups and ask a variety of questions.

An additional form of technology that instructors used to interact with students was email. Though Mills and Raju (2011) suggest that email can be an advantage to online learning, Greg and James pointed out that it was easy to get overwhelmed by the number of emails they received from students. The participants noted that students were more likely to email them questions than post them to the discussion board. Moreover, the participants used a variety of technology to communicate with students, keeping with the theme of multiple means of expression and action (CAST 2018; Chen et al., 2018).

Technology also served as an outlet for students to communicate with one another. Though many of the instructors incorporated discussion boards in their course, they found that they were not used frequently. As previous research has pointed out, instructors need to purposefully integrate discussion boards in a way that is related to the structure and the design of their courses (Boothe et al., 2018; Dell et al., 2015; Juan et al., 2011). Instructors who taught synchronously used breakout rooms to allow students to collaborate and communicate with one another. John expressed how he hoped that this would help students socialize with one another. Likewise, Lyla integrated small tasks in her course that students could complete while in the breakout rooms. She also integrated Top Hat questions to get a quick snapshot of student engagement and content comprehension.

While learner-learner interactions were not often observed on discussion boards or within the classes, the participants noted that students were using social media platforms and other outlets to communicate with one another. Moreover, while previous literature has identified that communication and collaboration among learners supports motivation, connectedness, and engagement (Boothe et al., 2018; Conrad & Openo, 2018; Juan et al., 2011; Sun et al., 2018), the participants felt that such interactions were happening beyond the tools used in their courses.

Mechanics of Calculations

According to the participants, much time was spent determining how to display statistical syntax online. James, Lyla, Greg, and John noted that their approaches stemmed from a desire to mimic the look and feel of teaching statistics in person, thus synthesizing both their pedagogical knowledge and technological knowledge. James explained that when he first started teaching introductory statistics online, he looked for software that he could use to record himself writing that captured the essence of writing on a chalkboard. Similarly, John, Lyla, and Greg created a space where they could teach synchronously in a manner similar to teaching in class. To make the videos, Lyla would record teaching using a whiteboard and document camera. She noted that filming ahead of the class allowed her to make edits and adjustments to the videos.

While teaching synchronously, both Lyla and John used document cameras connected to their laptops so that they could write and display statistical concepts. Greg primarily set up his teaching space to teach while writing on a whiteboard. The instructors highlighted the importance of both verbally explaining and visually displaying statistics content. The challenges the participants faced with regard to typing and displaying mathematical syntax (such as Lyla's attempt to use Microsoft Word for lessons) give credence to the arguments made by Trenholm et al. (2019) about the additional layer of complexity that instructors encounter while teaching introductory statistics courses online. Interestingly, as James acquired more experience teaching statistics online, he shifted away from handwritten videos

towards high-quality videos with typed up notes. He pointed out that this was due to wanting his videos to be clearer as he felt his handwriting was not particularly neat.

There was some variation regarding the use of statistical software in introductory statistics courses. Keeping in mind their audience as well as their content knowledge and technological knowledge, the instructors selected software and calculation methods to best meet the needs of their learners. They were purposeful in how they integrated statistical software, as they were aware of how technical issues could negatively impact student motivation and efficacy (Eichelberger & Leong, 2019). For example, Greg and James used R in their courses. They felt it was important to provide students with programming skills to visualize and analyze large data sets. James and Greg identified programming skills as a way for students to take ownership of their learning and to build their technological skillset. They explained that one of the reasons that they use R in their courses is because R is free, even if you are not a student. Furthermore, students can use the tool beyond the scope of their courses. They also noted that R is well-supported from a technical support standpoint and that students can take it upon themselves if they want to learn more about how to use the software.

Meanwhile, Lyla and John do not have students use software in their introductory statistics courses. In previous years, when John had more TA support, he had students use Microsoft Excel to conduct statistical calculations. He noted that, as a compromise, he used Maple TA in his introductory course to have students practice typing statistical syntax. Lyla expressed the importance of students conducting calculations using calculators in her class. Her hope was for students to develop a strong foundational understanding of what was happening in each calculation. Moreover, she used small datasets in her course to ensure the computations were manageable. John and Lyla explained that their students may not take statistics courses beyond their introductory course; therefore, they wanted to distinguish between statistical calculations and programming. John and Lyla mentioned that students are expected to use statistical software (e.g., R, SPSS, MATLAB) in upper-level statistics courses within their faculties.

Implications and Recommendations

It is clear that James, John, Lyla, and Greg took many factors into consideration when determining how to use educational technology in their online introductory statistics courses. They asked themselves questions about their students, the learning management system, and how they could adapt their teaching practices based on feedback and available support. A primary observation made by the instructors was the value of providing students with flexibility regarding assessments and content access in online spaces. When they transitioned to teaching online, they highlighted the importance of reshaping their courses to include multiple assessment opportunities to help students stay on track while learning from a distance. They also believed it was essential to provide students with continuous access to content so that they could engage with content at their own pace.

The instructors also noted the importance of using technology that accurately presented statistics syntax and provided students with the chance to practice writing statistics syntax and explaining the implications of statistical results. Though James, John, Lyla, and Greg used varying tools, each instructor emphasized the need to incorporate handwritten statistical syntax both as an instructor and as practice for students.

In order to successfully facilitate an online introductory statistics course, the instructors felt they needed opportunities to learn to teach statistics online in formal settings (e.g., professional development, webinars) and informal settings (e.g., discussions among colleagues). In some cases, this could include an online space where instructors can try new content, pedagogy, and technology. In other cases, this may involve providing instructors with lead time so that they can prepare and experiment with different tools, integrate opportunities for co-teaching, or share resources among instructors so that they do not have to start planning from scratch.

The findings from this study have many implications for various individuals within post-secondary settings, including instructors, teaching support units, academic leadership teams, and educational software developers. These recommendations include the following:

- Incorporation of opportunities for co-teaching between faculty and graduate students. While graduate students often have the chance to work as teaching assistants, it is less common for them to partake in teaching undergraduate courses. Allowing for instructors and graduate students to co-teach courses supports knowledge sharing in the domains of pedagogy and technology.
- Educational software developers may consider designing learning management systems that integrate social media tools and communication platforms (e.g., Discord, Slack) to support learner-learner interactions and learner engagement.
- Academic planning units may consider providing instructors with lead time for their courses. When changing the modality of introductory statistics from on-campus to online, establishing some lead time would allow instructors time to explore technology for course delivery, determine how to present statistical syntax, and investigate how to assess learners from a distance.
- Multiple assessment pieces should be used to allow students to build statistics efficacy and demonstrate their understanding. Assessments should draw on real data and consist of frequent, low-stakes evaluation, assignments that promote statistical communication and dissemination skills, and peer-collaboration.
- Regardless of online course modality (i.e., synchronous or asynchronous), instructors should leverage the flexibility of online learning and ensure that content is available to learners so they may access and review content at their own pace. This may include recording and posting live lectures and posting course content at the beginning of the term.
- Formal professional development workshops provided by teaching support units should include specific examples of how to integrate specific pedagogical and technological approaches in online courses. They may consider having other instructors demonstrate examples of how they use alternative forms of assessment, technology, or course modality.

Conclusion

Online introductory statistics courses provide learners with flexible options for pursuing their studies. Instructors can provide students with agency and autonomy of their learning by presenting statistical concepts using real data, recognizing the value and experiences each learner brings to the class, acknowledging the challenging nature of statistics, and incorporating multiple ways for students to demonstrate their understanding. These approaches combined with using technology to communicate with learners and facilitate online courses help create an authentic learning environment. These strategies help address the complex nature of interweaving synchronous and asynchronous discourse in online spaces as identified by Greg:

> There is no place for live theatre if everything has to look like an Avengers movie. You have got the two or three hours of super slick, massively prepared things; live theatre is a different business… But you have to treat them as to what is your value in a live lecture? I think that is one of the things – how can you capture more of that in an online course when you are thinking of an online course? (Interview, December 8, 2021)

Online facilitation of introductory statistics courses has the ability to empower learners by giving them the chance to play, rewind, and interact with educators at their own pace.

The interviews with the participants revealed that educators are receptive to using technology to enhance

communication and demonstrate statistical computations in online spaces. Likewise, they are invested in using innovative teaching approaches—such as assignments, participation, in-class tasks, and group work—to help students better understand statistical concepts. As educational technology continues to evolve, the reflections shared by these instructors act as a reminder to pause and reflect on how our teaching practices may continue to change and adapt to support our students.

References

Birt, L., Scott, S., Cavers, D., Campbell, C., & Walter, F. (2016). Member checking: A tool to enhance trustworthiness or merely a nod to validation? *Qualitative Health Research*, *26*(13), 1802–1811. https://doi.org/10.1177/1049732316654870

Boothe, K. A., Lohmann, M. J., Donnell, K. A., & Hall, D. D. (2018). Applying the principles of universal design for learning (UDL) in the college classroom. *Journal of Special Education Apprenticeship*, 7(3), 1–13. http://eric.ed.gov/?id=EJ1201588

CAST. (2018). *The UDL guidelines*. CAST UDL Guidelines. Retrieved January 1, 2022, from http://udlguidelines.cast.org/

Chen, B., Bastedo, K., & Howard, W. (2018). Exploring best practices for online STEM courses: Active learning, engagement & assessment design. *Online Learning*, *22*(2), 59–75. https://doi.org/10.24059/olj.v22i2.1369

Conrad, D., & Openo, J. (2018). *Assessment strategies for online learning: Engagement and authenticity*. Athabasca University Press. https://www.aupress.ca/books/120279-assessment-strategies-for-online-learning/

Creswell, J. W. (2013). *Qualitative inquiry and research design: Choosing among five approaches* (3rd ed). SAGE Publications.

Creswell, J. W. (2015). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (5th ed). Pearson.

Dell, C. A., Dell, T., F., & Blackwell, T. L. (2015). Applying universal design for learning in online courses: Pedagogical and practical considerations. *The Journal of Educators Online*, *12*(2), 166–192. https://doi.org/10.9743/JEO.2015.2.1

Eichelberger, A., & Leong, P. (2019). Using TPACK as a framework to study the influence of college faculty's beliefs on online teaching. *Educational Media International*, *56*(2), 116–133. https://doi.org/10.1080/09523987.2019.1614246

Farmus, L., Cribbie, R. A., & Rotondi, M. A. (2020). The flipped classroom in introductory statistics: Early evidence from a systematic review and meta-analysis. *Journal of Statistics Education*, *28*(3), 316–325. https://doi.org/10.1080/10691898.2020.1834475

Figueroa-Cañas, J., & Sancho-Vinuesa, T. (2018). Investigating the relationship between optional quizzes and final exam performance in a fully asynchronous online calculus module. *Interactive Learning Environments*, *29*(1), 33–43. https://doi.org/10.1080/10494820.2018.1559864

Garfield, J., Le, L., Zieffler, A., & Ben-Zvi, D. (2015). Developing students' reasoning about samples and sampling variability as a path to expert statistical thinking. *Educational Studies in Mathematics*, *88*(3), 327–342. https://doi.org/10.1007/s10649-014-9541-7

Gould, R. (2010). Statistics and the modern student. *International Statistical Review*, *78*(2), 297–315. https://doi.org/10.1111/j.1751-5823.2010.00117.x

Gould, R., Wild, C. J., Baglin, J., McNamara, A., Ridgway, J., & McConway, K. (2017). Revolutions in teaching and learning

statistics: A collection of reflections. In D. Ben-Zvi, K. Makar, & J. Garfield. (Eds.), *International handbook of research in statistics education* (pp. 457–472). Springer International Publishing. https://doi.org/10.1007/978-3-319-66195-7_15

Juan, A. A., Steegmann, C., Huertas, A., Martinez, M. J., & Simosa, J. (2011). Teaching mathematics online in the European area of higher education: An instructor's point of view. International *Journal of Mathematical Education in Science and Technology*, 42(2), 141–153. https://doi.org/10.1080/0020739X.2010.526254

Leech, N. L., & Onwuegbuzie, A. J. (2011). Beyond constant comparison qualitative data analysis: Using NVivo. *School Psychology Quarterly*, 26(1), 70–84. https://doi.org/10.1037/a0022711

McNamara, A. (2015). *Bridging the gap between tools for learning and for doing statistics* [Doctoral dissertation, University of California]. eScholarship. https://escholarship.org/uc/item/1mm9303x

Merriam, S. B. (2009). *Qualitative research: A guide to design and implementation.* Jossey-Bass Publishers.

Mills, A. J., Durepos, G., & Wiebe, E. (Eds.). (2010). *Encyclopedia of case study research.* SAGE.

Mills, J. D., & Raju, D. (2011). Teaching statistics online: A decade's review of the literature about what works. *Journal of Statistics Education*, 19(2). https://doi.org/10.1080/10691898.2011.11889613

Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. *Teachers College Record: The Voice of Scholarship in Education*, 108(6), 1017–1054. https://doi.org/10.1111/j.1467-9620.2006.00684.x

Nolan, D., & Lang, D. T. (2010). Computing in the statistics curricula. *The American Statistician*, 64(2), 97–107. https://doi.org/10.1198/tast.2010.09132

Sun, Z., Xie, K., & Anderman, L. H. (2018). The role of self-regulated learning in students' success in flipped undergraduate math courses. *The Internet and Higher Education*, 36, 41–53. https://doi.org/10.1016/j.iheduc.2017.09.003

Tishkovskaya, S., & Lancaster, G. A. (2010). Teaching strategies to promote statistical literacy: Review and implementation. In C. Reading (Ed.), *Proceedings of the Eighth International Conference on Teaching Statistics. International Statistical Institute.*

Trenholm, S., Peschke, J., & Chinnappan, M. (2019). A review of fully online undergraduate mathematics instruction through the lens of large-scale research (2000-2015). *PRIMUS, 29*(10), 1080–1100. https://doi.org/10.1080/10511970.2018.1472685

Yeo, M., Miller-Young, J., & Manarin, K. (2023). *SoTL research methodologies: A guide to conceptualizing and conducting the Scholarship of Teaching and Learning*. Routledge. https://doi.org/10.4324/9781003447054

PART IV

CONCLUSION: REFLECTIONS AND FUTURE DIRECTIONS FOR EDUCATIONAL TECHNOLOGY AND SOTL

15. Reflections and Future Directions for Educational Technology and SoTL

LAUREN HAYS; BRETT MCCOLLUM; AND JANICE MILLER-YOUNG

We, the editors of this book, set out to fill a gap in the SoTL literature related to educational technology. By emphasizing the importance of aligning research questions, methodologies, and theories in SoTL work, this book contributes to the existing body of knowledge and provides a path for future SoTL research in educational technology. Readers are invited to reflect on their own practices, engage in scholarly inquiry, and contribute to the ongoing dialogue about the role of technology in shaping the future of higher education.

While each chapter includes questions for reflection, we want to conclude the book by posing three fundamental questions that you should regularly ask yourself throughout your career:

1. What theory underpins your selection and use of educational technology?
2. What do you want to know about educational technology in your teaching and/or your students' learning?
3. What research methodologies do you use and how do they impact your investigation of educational technology in teaching and learning?

As we conclude this book, it is crucial to recognize that the use of educational technology in SoTL is not a destination, but an ongoing dialogue. The questions we have posed are not mere academic exercises but invitations to a deeper, more reflective engagement with technology's role in education. Reflective practice is a key component of scholarly teaching, and is often the seed from which a SoTL project germinates. Scholarly teaching and SoTL in turn advance our individual and collective understanding of the role of technology in education. This understanding emerges not from technological determinism, but from carefully considered, student-centred investigations that prioritize learning outcomes over technological novelty.

The future of educational technology research lies in our collective commitment to critical, contextual, and compassionate scholarship. By maintaining a focus on pedagogical purpose rather than technological potential, we can move educational technology from a set of tools into a meaningful resource for supporting how students learn, interact, and grow in increasingly digital learning environments. This book is but one step in a much larger conversation—a conversation that requires ongoing curiosity, rigorous methodology, and an unwavering dedication to understanding the complex intersections of people and technology for teaching and learning.

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