Introduction to the Edited Volume

Learner and User Experience Research: An Introduction for the Field of Learning Design & Technology

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Instructional Design | Learning Technologies | User Experience | Learner Experience | User-centered Design | Human-computer Interaction | Learning Design

Researchers have been engaged in productive scholarly endeavors at the intersection of Learning Design, User Experience (UX), Human-Computer Interaction (HCI), and associated disciplines for some time. Our work as editors has sought to capture and disseminate the collective voices of authors working in this area within a single volume. This book focuses on explicating the ontological and epistemological underpinnings of user-centered design (UCD) and UX as applied in the field of Learning/Instructional Design & Technologies (LIDT) with the goal of foregrounding the importance of learner experience (LX) as an emerging design paradigm for the field of LIDT. This chapter introduces the 15 chapters of our open access edited volume. The book is clustered in three parts of (a) Methods and Paradigms (5 chapters), (b) Models and Design Frameworks (6 chapters), and (c) LX Design-in-Use (4 chapters). This volume serves as a contribution to an emerging, transdisciplinary, and complex phenomenon that requires multiple literacies. LX is not only concerned with the effectiveness of designed learning interventions, but also with the interconnected and interdependent relationship between the learner- (or the teacher-/instructor-) as-user, the designed technology, novel pedagogical techniques or instructional strategies, and the learning context. The diversity and breadth of perspectives presented herein serve as a topographical sketch of the emerging focus area of LX and represent an opportunity to build upon this work in the future.

1. Introduction

When the editorial team first conceived of this book, our vision was to create an introductory resource focusing specifically on the theory and practice of learner experience (LX) and user experience (UX) in the field of learning/instructional design and technology (LIDT). We recognized that interest in UX and LX is growing in the field of LIDT, but also that researchers and practitioners seeking to learn and apply related methods must seek guidance from outside of our field. We therefore recognized the need for an interdisciplinary resource on UX and LX in our field. With this edited volume, we hope to address this need and spur further scholarship in this area. In an effort to establish broad impact, we agreed that this resource should be published as open access and geared towards a range of audiences interested in LX design.

Ultimately, this work is predicated on the premise that the complexity of designing for learning with technology cannot be adequately informed on the basis of theories and models derived from educational psychology and learning sciences alone. Learners' individual, perceived experiences of interaction with learning technologies also must be considered as critically important to the learning process. Therefore, the two overarching goals that guided our efforts were:

- To explicate the ontological and epistemological underpinnings of user-centered design (UCD) and UX as applied in LIDT and
- To foreground the importance of LX as an emerging design paradigm for the field of LIDT.

To this end, we solicited multiple, diverse perspectives that considered theoretical and practical issues of UX and LX across disciplines, interfaces, methods, and platforms. Our initial call for chapter proposals attracted a vibrant assortment of manuscripts relating to UX and LX in LIDT. In the following sections, we provide our rationale for this edited volume, followed by a discussion of why we chose to publish it as open access. We then detail the main sections of the edited volume, and synthesize each of the chapters associated with each section. Finally, we conclude the chapter by presenting three broad conjectures that seek to characterize LX broadly, on the basis of our experiences developing this volume over the past year.

1.1. Why This Book?

Considerations of UX are core to many of the sister disciplines of LIDT (e.g., human-computer interaction, information technology), but historically, little attention has been given to LX or to the process of LX design in LIDT. With sister disciplines leaning towards more human-centered approaches to design, could this signal a shift in the field of LIDT? There is no question that user-centered design (UCD) methods increasingly are being applied in learning design contexts (Baek et al., 2008; Barab et al., 2005; Ebner & Holzinger, 2007; Fernandez-Lopez et al., 2013). However, in addition to learning design providing learners effective digital learning tools to efficiently propel them towards learning outcomes, learning designers should also be concerned with construction of digital learning tools that are pleasing and easy to use. Our collective experiences directing LIDT design studios and working in industry have underscored the importance of both (a) effective tools and ease of use and (b) meaningful pedagogies and theory. This is further supported by our experiences developing this edited volume, which has convinced us that researchers and practitioners are not only using a variety of methods and processes from human-computer interaction (HCI), UX, and UCD in LIDT, but are doing so quite ably and with very promising outcomes. The body of knowledge included in this edited volume serves as a testament that these human-centered methods and processes external to our field have proved to be useful for both scholarship and practical application in LIDT. On the surface, it is tempting to adopt the view that LXD could be a new and emerging focus area in our field, and admittedly, this could indeed be the case. However, closer inspection of the emerging LX phenomenon unveils a number of issues that bear further consideration, a selection of which we outline below.

Firstly, there is little agreement in terminology within our discipline. While terms like LX, LXD, LCD, and learning design have been readily adopted, it is unclear how they are defined. Indeed, many terms are used informally, interchangeably, and without precision. For example, learning experience and learner experience are both referred to as LX. What do these different terms mean? Are they fungible or distinct? What are their parameters and how are they operationalized? How do the concepts of learner/learning experience and learner experience design differ or overlap? Similar questions can be found in the tradition of HCI, where debate regarding how UX design is defined, situated, and performed is ongoing. In fact, it is in recognition of these debates that we have opted to use the more semantically established term "UCD" throughout the current chapter. Ultimately, the terminology that is frequently used to refer to LX and related concepts in our field lacks semantic clarity, thereby complicating attempts to draw comparisons and build upon prior results.

Secondly, although learning designers are applying methods and processes of UCD in their design contexts, there are as of yet no guidelines for this in LIDT. This is in stark contrast to HCI or sociotechnical systems' design, wherein design principles can be found in abundance. Bridging this research-to-practice gap is critical to assist designers in the

selection and application of methods that are germane to their design goals, appropriate for a given design phase, and resonant with intended design outcomes. For example, learning designers might consider having participants complete a usability questionnaire at the end of a design cycle. While this could yield a positive score in regards to a learning technology's ease of use, ultimately it could have a deleterious effect on ongoing design refinements. Even though usability evaluation can result in a positive technological quality index—which is a necessary quality indicator—this is insufficient for an active, learner-centered learning design. LX design also requires additional quality indicators such as pedagogical usability and sociocultural considerations (discussed in depth by Jahnke, Schmidt, Pham, & Singh in this volume). Usability studies are useful to add to LX studies and should be performed to shed light on effectiveness, efficiency and appeal of learning (Honebein & Honebein, 2015), learner behavior, and on improvement of learning opportunities. However, positive usability scores alone are not particularly helpful because they could end the improvement cycle and could lead stakeholders to false conclusions. Guidelines are needed for aligning and mapping the methods and processes of UCD onto established LIDT design processes.

Thirdly, LX as an emerging area of research and practice has made neither substantial nor sufficient connections to the theoretical foundations of LIDT. How do the methods and processes of UCD align with how we explain, predict, and understand learning, and how do they potentially challenge and extend our existing knowledge? LIDT is inherently interdisciplinary, so it is unsurprising that theories born in the field of HCI have found resonance in our field, such as distributed cognition and activity theory. However, sharing a theoretical lens falls short of establishing a theoretical foundation upon which a tradition can build. Further work is needed that considers guiding philosophical orientations and seeks alignments on a fundamental level.

These issues—lack of semantic clarity, inadequate methodological guidelines, and insufficient theoretical grounding—represent the three major, most troublesome issues but are only a fraction of the challenges that face those interested in LX. Serious attention to these foundational issues is necessary if LX ever is to transcend the collective canon of the LIDT tradition. To our knowledge, no such efforts have been made to-date; hence, there is a need for additional investigation with a book like this.

1.2. Why Open Access?

We chose to publish this book as open access because this publication model lacks many of the barriers of traditional publication models while also presenting unique opportunities for authors and readers. Using open access, barriers such as cost, ability to access, and ability to share are largely obviated. Anyone, anywhere can freely access and share any of the materials in this edited volume at no cost (as long as authors are credited). The open access model allows this work to take on a life of its own and to continue to be developed beyond the date of publication. These unique opportunities rest on the foundation of an important set of permissions that perhaps have been best articulated in our own field in the work spearheaded by David Wiley and his colleagues (Hilton III et al., 2010; Wiley et al., 2014). These permissions are referred to as the "four R's" of open educational resources and are made possible through the use of Creative Commons licensing. As outlined below, and on the condition that authors are appropriately credited, readers of this volume are granted permission to:

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2. Inside This Edited Volume

This edited volume is composed of 16 unique contributions that were developed altogether by a total of 40 authors. All chapters were vetted using a rigorous peer-review process. Initially, all author submissions were closely reviewed by the editors who provided detailed feedback. After revisions were made by the authors, chapters were sent out for peer review. Each chapter was reviewed by at least two different authors who also have a chapter published in this volume. Based on peer review feedback, authors revised their chapters a second time. Each of these revised chapters was again reviewed by the editors before making a final decision to accept a chapter for inclusion in the edited volume. Authors of accepted chapters were then asked to make final revisions. After authors incorporated final revisions, chapter manuscripts were sent out for professional copy editing and reviewed one final time by the authors and editors before being released for publication.

Upon review of the final chapters, authors' work fell fairly evenly into the following four categories:

1. Introduction (this),
2. Methods, paradigms, and theories of LX design (5 chapters),
3. Models and design frameworks for LX (6 chapters), and
4. LX design-in-use (4 chapters).

The chapters that fall within these categories are presented in the following three sections. Each chapter is briefly summarized, with its importance to readers of this volume then being briefly highlighted.

2.1. Methods, Paradigms, and Theories of LX Design

This edited volume begins with six chapters representing an assortment of perspectives on methods, paradigms, and theories related to LX design. The chapters in this section illustrate how theories and methods that have found resonance elsewhere could be applied advantageously in LX. These contributions add to a growing repository of theoretical and methodological foundations for LX and advance our understanding of how these might be applied practically in LX design.

The entry point for this section is a chapter that focuses on methods. Entitled, *Methods of User Centered Design and Evaluation for Learning Designers*, authors Schmidt, Earnshaw, Tawfik, and Jahnke highlight the importance of not only referencing theory in learning design, but also of creating positive and enjoyable learner experiences. To this end, the authors situate their work in theories commonly referenced in LIDT and present with detail a broad range of methods and processes frequently used in user-centered design that can be productively applied in LIDT (e.g., personas, scenarios, prototyping, usability testing). Helpful examples of how to apply these methods and processes in learning design contexts are provided. This work contributes to our understanding of important theories at the intersection of HCI and LIDT and establishes a repertoire of useful methods and processes to guide burgeoning learning designers seeking to engage in learner-centered design and research.

The next chapter in this section, Gray's *Paradigms of Knowledge Production in Human-Computer Interaction: Towards a Framing for Learner Experience (LX) Design*, conceives of LX design as an emerging, transdisciplinary field that incorporates perspectives of HCI, UX, and LIDT. Gray positions HCI knowledge as foundational to UX before synthesizing the historical and conceptual alignment of paradigms, waves, and theoretical approaches in HCI. Recognizing that research in the field of LIDT largely has been isolated from HCI, Gray juxtaposes the LIDT community's tendency to focus on design processes with the HCI community's focus on design methods. To pursue connections between the two fields, Gray attempts to align LIDT processes with HCI and UX methods and concepts (i.e., personas, prototyping, usability testing, etc.). Building on identified gaps in LDT and HCI/UX, Gray proposes a set of guiding principles for shaping the field of LX design. Importantly, this work contributes to our understanding of the relationship between LIDT, HCI/UX, and LX design and calls attention to areas critically in need of further research.

Following this is a chapter that foregrounds the crucial importance in LX of connecting theory with design and evaluating not only hedonic and perceptual dimensions of designed solutions, but also learning impact. In their chapter

Theories of Change in Learning Experience (LX) Design, authors Bowen, Forssell, and Rosier connect theory at a meta-level with LX methods and processes through the application of theories of change. Recognizing the parallels between UX and LX, the authors highlight important distinctions between the two. Both are guided by theory, yet generally draw from different traditions. Specifically, UX design is based on user research, whereas LX design focuses on how people learn. In acknowledgement of the centrality of learning in LX, the authors present theories of change as a sort of epistemic lodestone to guide evolving LX designs. Importantly, the authors stress the necessity of testing underlying hypotheses to validate learning theories and UX factors that support specific design solutions. To illustrate, the authors present two digital learning tools design cases that were guided by theories of change. This approachable confluence of theory and practice from Bowen and his colleagues provides an actionable framework for applying and testing theory as designerly practice.

Flow Theory and Learning Experience Design in Gamified Learning Environments by Vann and Tawfik acknowledges the vital role of theory in learning design, but cautions that privileging theory over considerations of LX can lead to the emergence of unforeseen design flaws. The authors therefore position flow theory as a means not only to describe underlying processes of learning but also to take into account considerations of LX. Following a brief introduction to flow theory, the authors describe how dimensions of flow theory might be linked to learning design. A review of prior studies that apply flow theory in gamified learning contexts is provided. Further, Vann and Tawfik describe the redesign of a gamified online professional development course for university faculty to facilitate the understanding of flow theory in learning design practice. Using the design case approach, the authors describe designed gamification elements and make explicit connections to flow theory while remaining cognizant of corresponding learning experiences.

Rounding out this section is Kimmons' *Color Theory in Experience Design*, a chapter that considers an aspect of design that is rarely discussed by professionals in systematic ways outside the visual arts—color. Kimmons presents color from the perspective of affect and its potential role in influencing intrinsic motivation. The author then provides an in-depth overview of color theory, from the physics of color to color notation to how color is digitally represented in terms of hue, saturation, and brightness. Kimmons links color theory to UX and LX by considering those aspects of color that influence human emotion and how designers might consider color-use within this frame. The author presents useful heuristics to guide selection and use of color LX design, including attending to contrast, attention, meaning, and harmony. This chapter stands apart as an application of visual design theory as applied in LX design practice, contributes to our understanding of how diverse disciplines contribute to LX, and delightfully illustrates the multiple competencies required of LX designers.

2.2. Models and Design Frameworks for LX

The second section of this edited volume includes six chapters exploring an assortment of models and design frameworks for LX. Drawing from a broad spectrum of views and approaches, authors in this section grapple with a range of issues relevant to conceptually grounding individual approaches and informing their design processes. Collectively, these frameworks begin to unveil the preliminary gestalt of LX as a focus area beginning to emerge in LIDT.

The section begins with *Sociotechnical-Pedagogical Usability for Evaluating Learner Experience in Technology-Enhanced Learning Environments*, a chapter by authors Jahnke, Schmidt, Pham, and Singh that claims technological usability evaluation alone is insufficient to account for the multiplicity of perspectives learning designers must consider when seeking to perform usability research on learning technologies. Although research in the field of learning design has increasingly applied methods from usability and UX research for evaluating and improving LX with learning technologies, the authors argue that learning designers must not only consider the technological dimension of usability, but also the pedagogical and social dimensions. To operationalize the framework, the authors present a literature review of 13 articles published since 2006 that provide associated evaluation criteria. On the basis of these prior studies, the authors propose a conceptual framework for *sociotechnical-pedagogical usability*. A diagram illustrates intersections and relationships of the three dimensions with detailed explanations. The chapter concludes with a set of sociotechnical-pedigogical usability design recommendations for hybrid or online courses. This chapter situates usability as a useful evaluation method for LX while at the same time extending and refining underlying principles to better align with learning design.

The chapter *Learning Experience Design: Challenges for Novice Designers* follows with a conceptual design process that positions LX design as an ill-structured problem-solving activity, especially when comparing novice and expert designers. Authors Chang and Kuwata present LX design as a confluence of four interrelated factors, including: (a) learning experience, (b) human-centeredness, (c) goal-orientation, and (d) design. On this basis, the authors present a conceptual design process intended to guide LX design practice, including problem generation, problem-solving process, and solution generation. Chang and Kuwata illustrate this process with an engaging, graphic novel-like LX design scenario that effectively juxtaposes novice and expert design approaches. Several practical suggestions are provided for novice learning designers. While this chapter's relatable style will likely capture readers' attention, the authors' ability to locate LX within established theoretical and procedural traditions of our field will truly resonate.

In a nod to well-established practices of instructional design (ID), authors Stefaniak and Sentz position needs assessment as a way to validate contextual factors in user experience design practice so as to promote learning transfer. Their chapter, *The Role of Needs Assessment to Validate Contextual Factors Related to User Experience Design Practices*, situates UX design practice in the context of instructional design with the goals of facilitating learning and improving performance. These authors promote a systems approach to UX design, maintaining that learning environments are open and therefore complex systems, which underscores (a) the importance of contextual analysis to understand learners' work practice and (b) needs assessment to identify, classify, and validate learner needs relative to work practices. The authors argue that typical approaches to needs assessment are narrow—often only focusing on learner analysis—and fail to conceive of learners as users, which could lead to overlooking important contextual factors that could impact learners. To that end, the authors present a framework to leverage needs assessment outcomes within UX design, including detailed explanations for each element and their relationships. A family of heuristics is provided to help learning designers apply the proposed framework. Firmly rooted in the orthodox traditions of LIDT, this chapter illuminates novel ways to approach established methods.

In the next chapter, *The Design Implementation Framework: Guiding Principles for the Redesign of a Reading Comprehension Intelligent Tutoring System,* authors McCarthy, Watanabe, and McNamara introduce the Design Implementation Framework (DIF) as a means to guide the design and UX of intelligent tutoring systems (ITSs). The authors argue balancing ease-of-use, enjoyment, and efficacy in good ITS design can be achieved by applying the five cyclical phases of the DIF, which include: (a) defining and evaluating the problem, (b) ideation, (c) design and user experience, (d) experimental evaluations, and (e) feedback and implementation. A case study is presented, illustrating the DIF in practice and highlighting the variable nature of the process across various design contexts. The authors describe methods and outcomes of each phase and how adjustments should be made in accord with evolving design conditions. As the chapter progresses, the authors also underscore the importance of evaluation to the DIF for driving design changes. Observant readers will take heed not only of the authors' well-articulated design framework, but also their deft ability to flexibly enhance their approach through data-based decision-making—arguably a skill of the superior designer.

In the chapter *From Engagement to User Experience: A Theoretical Perspective Towards Immersive Learning*, authors Oprean and Balakrishnan present a conceptual design framework blending immersive technology and user/learner experience to impact learner engagement. The authors present various attributes of immersive technologies, including virtual reality (VR), augmented reality (AR), and mixed reality. To bridge technology and outcomes, Oprean and Balakrishnan then propose a framework that describes the role of UX in designing immersive technology to promote intended learning outcomes. The authors present concepts of immersive learning and UX factors as central to amplifying perceptions of presence, embodiment, engagement, and novelty. These, in turn, influence learner engagement. The authors provide examples in which they apply immersive technologies aimed at enhancing learner engagement, concluding that their immersive framework could promote better understanding of the immersive technology attributes that might impact learner engagement.

Concluding this section is a chapter presenting an LX-focused workflow for the systematic design of physical—not digital—game-based learning interventions. Abbott's *Intentional Learning Design for Educational Games: A Workflow Supporting Novices and Experts* synthesizes a set of LX design principles and links each principle to characteristics of

game-based learning. The chapter then proposes a mapping of common weaknesses in GBL to potential LXD-informed improvements. Abbott further proposes a guided workflow for developing effective and learner-centered educational games, consisting of four groups of overlapping design activities with various foci, including ID, empathy/emotional design, interaction design, and game design. Abbott elaborates on each step of this workflow with a design case. Applying LX design principles to a game design process ensures the connection between appropriate pedagogical foundations and the needs and desires of learners. Abbott's masterful ability to meaningfully situate LX within a multitude of complex and competing design processes is a particular highlight of this section. The chapter's focus on physical games provides a fresh perspective that even the most seasoned designer surely will appreciate.

2.3. LX Design-in-Use

The third and final section of this edited volume consists of four chapters that relay cases of LX design-in-use. By design-in-use, we refer to the applied use of LX methods and processes to create digital environments for learning. These chapters serve as exemplars on multiple levels. On one level, they represent worked examples that detail the actions, events, rationales, challenges, etc. of LX design from beginning to end. On another level, the chapters are success cases of LX design, highlighting the synergistic interplay of pedagogy and theory with perceptions of usefulness and other hedonic aspects.

Beginning this section is Quintana, Haley, Magyar and Tan's *Integrating Learner and User Experience Design: A Bidirectional Approach*, in which the authors present their vision for learning design as a bidirectional interplay between UX designers and LX designers. To support their bidirectional approach, the authors foreground the complexities introduced to the design process as a result of conceiving of learners as users. A balance between UX and LX can be struck when designers consider operational tasks from the UX perspective and learning tasks from the LX perspective. The authors introduce a heuristic "learning with software" approach to evaluating learning tools, which adapts known usability heuristics to a range of learning-related factors. Quintana and her colleagues then present two design cases that feature this approach to learning design, with distinct contributions from both UX and LX perspectives. The first design case illustrates how UX designers took on a primary role, with support from LX designers to identify learners' concerns, examine features from the perspective of learning tasks, and provide feedback on design outcomes at various stages. The second case demonstrates how a learning activity was designed and implemented by LX designers to guide instructors through the development of learner personas (a well-known approach within UX design processes). The authors conclude their chapter with helpful principles for guiding LX/UX collaborations. Their work not only illustrates how UX and LX can be combined synergistically, but also serves as encouragement for burgeoning learning designers who may be intimidated by the perhaps overwhelming breadth of knowledge, skills, and design acumen subsumed in LX design. With careful planning, learning designers can work in tandem with UX designers to create effective and pleasing designs.

In the chapter *Participatory Design and Co-design—the Case of a MOOC on Public Innovation*, authors Cavignaux-Bros and Cristol present a case that applies participatory design and co-design methods to the design of a Massive Open Online Course (MOOC). As a primary thrust of the chapter, the authors detail how they implemented co-design across three stages of their timeline and participatory design in a fourth and final design stage prior to launch. Explanations are provided of the activities conducted in each design stage, along with figures illustrating the deliverables created by the participants. The outcomes of the participatory design and co-design case are presented from two perspectives. One is the final production of the course, which is reported to have positively influenced the number of enrollments; the other is the reflections on LX design as a professional development outcome of the design teams. By focusing on participatory design and co-design as potentially useful methods for instructional designers and user experience (UX) designers, these authors provide useful insight into methods that historically have been overlooked in LIDT.

The case presented by Raza, Penuel, Jacobs, and Sumner, *Supporting Equity in Schools: Using Visual Learning Analytics to Understand Learners' Classroom Experiences*, serves as an application of UX design methods to the design of a visual learning analytics dashboard for teachers to promote equitable instruction at the classroom level. Couched in relevant literature, the authors provide justification for the use of data-driven decision making in schools and how equitable instruction may be supported through three key constructs: coherence, relevance, and contribution. The

authors present a design conjecture that contends LA dashboards that embody these constructs could promote equity for diverse student populations by supporting teachers' data-based decision-making. They then elaborate on how think-aloud and cognitive interview methods supported the design of their LA dashboards. Their work illustrates the application of established UX methods in the design of an instructional technology intended to enhance desired classroom experiences. This work contributes to our understanding of the multiplicity and complexity of LX, which extends beyond learners to be inclusive of instructors as well.

This section concludes with the chapter *Think-Aloud Observations to Improve Online Course Design: A Case Example and "How-to" Guide* by Gregg, Reid, Aldemir, Gray, Frederick, and Garbrick. These authors present a case that uses think-aloud observations (TAO) methods to explore the perceived UX of online course designs within a learning management system (LMS). On the basis of Dewey's transactional theory of knowing, the authors present UX as the intersection of learner experience and pedagogical usability. In addition to the goal of making LMS courses easier to navigate, the authors also identify UX design principles and methods that could be used as references for others in the field. The authors explain their design case with great detail using their data collection, data analysis, and findings. Five design principles for maximizing the UX of online courses offered within an LMS are provided: (a) avoid naming ambiguities, (b) minimize multiple interfaces, (c) design within the conventions of the LMS, (d) group related information together, and (e) consider establishing consistent design standards throughout the university. Drawing from prior literature and self-reflections, the authors provide steps for others to conduct a TAO study. Their work illustrates UX testing methods applied to learning design and contributes to our understanding of how to conduct a TAO method to both enhance a learning design and contribute to the general knowledge base of the field.

3. Discussion

Having reviewed the unique contributions of the various authors and author teams, our attention now shifts to a more integrative perspective. What interpretations might we draw from the collection of diverse perspectives presented here? Our experiences as editors in overseeing the development of this volume certainly have led to a number of unique insights into the character of the LX phenomenon, which we proffer as three overarching axia below and discuss in the following sections:

1. Axiom of Transdisciplinarity: Although LX represents a confluence of many fields, it emerges as palpably distinct. It is intrinsically and inextricably transdisciplinary, is heavily influenced by UX design, and has particularly deep roots in LIDT.
2. Axiom of Complexity: Complexity is central to the LX phenomenon. LX is not only concerned with the effectiveness of designed learning interventions, but also with the interconnected and interdependent relationship between the learner-as-user, the designed intervention, and the learning context.
3. Axiom of Multiple Literacies: Accepting LX as a transdisciplinary and complex phenomenon implies that multiple literacies are therefore intrinsic to LX design. By extension, an extensive repertoire of knowledge, skills, and abilities across a range of disciplines is imperative.

3.1. Axiom of Transdisciplinarity

To situate LX as transdisciplinary suggests that it must first be distinguished from terms such as *multidisciplinary* and *interdisciplinary*. To this end, we draw from Choi and Pak's (2006) frequently cited paper in which they rigorously define these terms. Firstly, the term *multidisciplinary* involves various disciplines seeking to achieve a common aim; however, contributions remain distinct and interactions tend to be largely siloed. A great deal of instructional design (ID) projects can be described as multidisciplinary. ID projects in which subject matter experts provide content expertise and instructional designers segment and sequence the content in such a way as to promote identified learning objectives exemplify multiple disciplines contributing to a common goal, but their efforts are not integrated or tightly coordinated. Secondly, the term *interdisciplinary* refers to the combination of and interaction between two or more disciplines towards a common aim, the result of which is so closely interwoven that it is not possible to distinguish the discipline from which any given contribution was made. An example from the field of LIDT would be from the methodological

approach referred to as educational design research (EDR—also known as design-based research; cf. McKenney & Reeves, 2018). EDR advocates for establishing seamless collaborations between researchers and practitioners to facilitate efficient establishment, communication, and implementation of design solutions so as to facilitate educational impact. While the inputs of EDR that lead to designed solutions come from distinct traditions of research and practice, the final outcome cannot be attributed to any single discipline. Third and finally, we turn to the term *transdisciplinary*. This approach tightly integrates perspectives of multiple disciplines (as does interdisciplinarity) but also transcends them, which can lead to the emergence of entirely new knowledge. Given the nature of transdisciplinarity, it is therefore not possible to find an example inside the field of LIDT; however, examples can be found in disciplines outside of our own that have integrated aspects of LIDT to create something entirely new. A particularly recognizable transdisciplinary discipline can be found in the field of learning sciences. Learning sciences is a confluence of many fields, including philosophy, neuroscience, linguistics, educational technology, information science, etc. While each of these fields certainly makes its own contributions, the focus and methods of the learning sciences to advance the scientific understanding of learning transcend those of any single field.

Similarly, LX represents a confluence of many fields, including HCI, information technology, education, learning and instructional design, educational technology, psychology, etc. While individual contributions from those fields are evident in LX, the manner in which those contributions manifest and their intended outcomes are distinct. For example, usability testing is perhaps the most recognizable user research method of UX. This method is also widely used in LX. However, the manner in which it is applied and to what ends is distinct. LX usability not only considers the technological usability of a given learning technology, but also the influence of pedagogical and social factors. Further, LX usability's concept of the user is multifaceted, shaped by considerations of technology usage as well as considerations of learning. Moreover, LX necessarily requires a broad interpretation of context, including not only the immediate physical context but also sociocultural factors that could impact learning. The outcomes of LX usability transcend the bounds of merely improving the design of learning technologies, concomitantly informing our theoretical understanding of how people learn with and through learning technologies. While the additive and interactive aspects of multi- and interdisciplinarity are evident in this example, the more holistic nature of the approach serves to illustrate how LX can go beyond the traditional bounds of contributing disciplines. In the current volume, the transdisciplinary character of LX is particularly well represented in Gray's *Paradigms* chapter and Jahnke and colleagues *Socio-technical Pedagogical Usability* chapter.

3.2. Axiom of Complexity

We argue that LX is an emergent property of a complex, interconnected and interdependent system that includes, but is not limited to, the designed intervention, learner-as-user, and learning context. To situate LX within the frame of complexity, we turn to complexity theory. Complexity finds its roots in chaos theory and has found a limited foothold in the field of LIDT (e.g., Jacobson & Kapur, 2012; Jonassen, 2000; Reigeluth, 2004). Complexity theory eschews deterministic and causal models of predictability, instead adopting a more organic, holistic, and non-linear perspective. Particularly relevant to LX are the complex system properties of dynamics and emergence.

Complex systems are comprised of many component parts that themselves can be simple. What leads these systems to be complex are the connections and dependencies between the system components, which all interact in a non-linear manner. On a small scale, causal inferences can be made regarding the interactions between system components; however, this becomes impossible at a large scale. How the system behaves cannot be predicted by considering the component parts. Instead, behavior is determined by the dynamic nature of interaction between interconnected and interdependent component parts. However, the system's behavior is also dependent upon its context or environment. Therefore, the system's behavior emerges from a complex interplay of dynamic interactions and context.

The properties of complex systems also can be applied to describe the phenomenon of LX. With the understanding that any attempt to describe a complex system is inherently reductive, many component parts can easily be identified that contribute to LX, such as the tools that comprise the designed intervention (e.g., networks, computers, software, operating systems, user interfaces), the pedagogical strategies employed (e.g., instructions. sequencing, scaffolding),

the learner-as-user (e.g., elementary student, journeyman carpenter, marketing trainee), and so-on. Further, the contexts within which these component parts are situated contribute, such as the social context (e.g., university course, corporate training, high school homeschooling), the nature of the social context, (e.g., formal, informal), and sociocultural factors influencing the social context (e.g., communication norms, social mores, shared values, native language). No single factor in this complex ecosystem individually affects learning; instead, it is the nature of interaction between these components that gives rise to the phenomenon of learning as an individually perceived, unique experience. This individual experience could therefore be described as an emergent property of a complex system. Readers can find a particularly apt representation of complexity in LX in the current volume in Abbott's *Intentional Learning Design for Educational Games*.

3.3. Axiom of Multiple Literacies

Assuming for the purpose of argument that the transdisciplinarity and complexity conjectures proffered above are not false, it follows that a vast array of corresponding knowledge, skills, and abilities that draw from a range of disciplines is needed. A potential implication of this could be that the level of expertise required to engage in LX research and practice is so formidable that it is simply not feasible. However, while LX design indeed does require multiple literacies, instructional and learning designers do not necessarily need to individually master all of the multiple literacies of LX. Instead, LX designers should strive to establish methods and processes to productively collaborate with others from contributing disciplines (e.g., HCI experts, UX designers, interface designers, etc.).

The prospect of instructional designers and/or LX designers collaborating with contributing disciplines, for example by using participatory and co-design methods, presents opportunities for powerful synergy. This could lead to improved outcomes along at least two dimensions: (a) enhancement of the general LX for learners-as-end-users and (b) promotion of professional development for all members of a design team (e.g., project managers, training consultants, and instructional designers). In this manner, LX design—as a participatory or co-design approach—could potentially serve as a method for professional development of educators. This prospect echoes conclusions from other areas of our field. Indeed, Voogt and colleagues (2015) highlight the situative and generative nature of such collaborations as being particularly conducive to professional development. Further, scholars in the area of educational game design (e.g., Charsky, 2010; Hirumi et al., 2010a, 2010b; Van Eck et al., 2017) have recognized that the multiple literacies required in game design would be impossible for learning designers to reasonably master. Therefore, establishing productive methods and processes of collaborating with game developers is recommended. Specifically, "[T]he ID person must be an advocate for appropriate learning experiences throughout the entire process and work with those advocates involving different areas of development, such as the functionality, the delivery, and the affective components of the form itself" (Hirumi et al., 2010b, p. 23). Readers are specifically referred to Quintana and colleagues' *Integrating Learner and User Experience Design* chapter and Cavignaux-Bros and Cristol's *Participatory Design and Co-design* chapters in this volume for examples of productive LX approaches that integrate multiple literacies across disciplines.

4. Conclusion

The body of scholarship in this edited volume represents a significant step towards firmly and formally establishing LX within the tradition of LIDT. Although LX is an embryonic and emerging area of focus in our field, the broad and diverse perspectives presented in this volume represent remarkable maturity, intellectual rigor, and scholarly merit. To be sure, researchers have been engaged in productive scholarly endeavors at the intersection of learning design, UX, HCI, and associated disciplines for some time (e.g., Boling et al., 2015; Moore et al., 2014; Nokelainen, 2006; Schmidt, 2014; Tawfik et al., 2018). Our work as editors has sought to capture and disseminate the collective voices of authors working in this area within a single volume. Adopting the metaphor of cartography, the vibrant diversity and breadth of perspectives presented herein serve as a topographical sketch of the emerging focus area of LX; however, far more work is needed to fully map the landscape.

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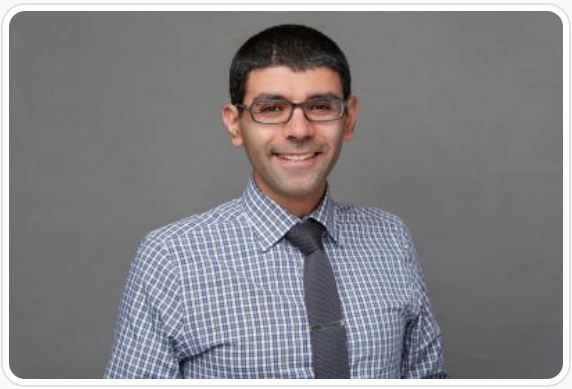

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