ROUTLEDGE

Creating Design Knowledge in Educational Innovation

Theory, Methods, and Practice

Edited by Inger-Marie Falgren Christensen, Lina Markauskaite, Nina Bonderup Dohn, Dwayne Ripley, and Roland Hachmann

CREATING DESIGN KNOWLEDGE IN EDUCATIONAL INNOVATION

Examining how research-informed design knowledge is created, represented, and used in educational research and innovation projects, this book offers theoretical, methodological, and practical guidance on how to (and how not to) create, represent, and (re)use research-informed design principles.

The chapters explore how educational researchers, designers, teachers, and other innovating practitioners can make outcomes of educational research and innovation projects scalable, readily applicable in educational design, and impactful on practice. They offer methodological "know-how" that is theoretically robust and grounded in research and design experiences. Providing critical reflection on current theories, methods, and practices, this book also considers directions for the future in light of developments in semantic web technologies, AI, and other emerging technologies.

This book is a helpful guide for researchers, research students, and innovation designers who aim to produce and apply design knowledge that is robust, grounded in research, and practically useful as a part of diverse research and innovation projects.

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FOREWORD

The Corona pandemic and the lockdowns that followed in several countries caused challenges in many aspects of academic life, including face-to-face networking activities and research visits. One such research visit was scheduled for 2021 when researchers from the Department of Design, Media and Educational Science at the University of Southern Denmark were to visit colleagues at The Sydney School of Education and Social Work at The University of Sydney in Australia. Since a physical visit was not a possibility, we decided to conduct a series of joint online seminars in which we could explore a common interest in design knowledge in educational research and innovation.

In seven live, online sessions from September 2021 to June 2022, we took turns presenting issues of interest and facilitating discussions around these. It was these joint explorations that made us realise that the field is highly fragmented and that many researchers and practitioners face challenges when searching for relevant literature to inform their work creating design knowledge. This resulted in our decision to continue our joint explorations and produce this edited book. Some of the chapters are co-authored by scholars from both institutions and involve collaborations between junior and senior researchers.

The main chapters of the book provide a synthesis of design knowledge in educational research and innovation from theoretical, methodological, and practical perspectives. Acknowledging our predominantly Western epistemological roots, we have invited scholars from diverse backgrounds to contribute commentaries. These commentaries provide additional perspectives on design knowledge in educational research and innovation. Diversity has many facets, and we are very grateful to our commentary scholars for broadening the set of ideas offered in this book.

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INTRODUCTION

Creating Design Knowledge in Educational Innovation

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Introduction

Research and innovation projects in education often aim to produce principled practical knowledge that can inform educational design. This principled practical knowledge takes diverse forms, such as design principles (van den Akker, 1999), design patterns (Goodyear & Retalis, 2010), design conjectures (Sandoval, 2004), design frameworks (Goodyear et al., 2021), and design guidelines (Bates, 2022). Such knowledge products are of high potential practical value as they offer a way to connect educational research with design and, in this way, may impact educational practices at scale. They hold a promise to make educational research outcomes more easily applicable in practice and educational practice more robustly informed by research knowledge.

However, theoretical foundations that underpin many current research endeavours to create principled practical knowledge are vague, and methodological guidance is patchy. It is not surprising that educational research and innovation projects often struggle to produce design outcomes that can be easily (re)used across settings and achieve impact at a scale. There is a significant disjunction between current methodological know-how on the production of research-informed knowledge for educational design and actual practices.

On the one hand, some research approaches, such as design-based research (DBR Collective, 2003), design experiments (Collins, 1992), educational design research (McKenney & Reeves, 2012), participatory design research (Cumbo & Selwyn, 2022), and design-based implementation research (LeMahieu et al., 2017), specifically aim to connect educational research with educational innovation to produce knowledge that is readily usable in educational design. However, in practice, these approaches strongly focus on the research process and theoretical outcomes

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while obscuring design processes and knowledge. Further, the current focus on the rigour of empirical evidence often limits the usability of these approaches, making them unfit for the broad range of educational research projects that have tight timelines and small budgets.

On the other hand, educational research and innovation projects that produce knowledge for educational design extend far beyond specialised design research methods to include studies of current designs and teaching and learning practices that result in design recommendations (Rizzuto, 2017) as well as other principled practical knowledge. While these projects do not result in rigorously tested and validated design solutions, they produce knowledge that informs design practices. However, these "peripheral" design products and the practices employed to create them often remain implicit and un-reflected and thus lack methodological credibility.

The aim of this book is to articulate and discuss foundational ideas and offer theoretical, methodological, and practical guidance on how to create, represent, and (re)use research-informed design principles and other principled practical knowledge products for educational design. The chapters reflect critically on current theories, methods, and practices and discuss directions for future development of the field. The book is written for educational researchers, research and postgraduate students, innovation designers and team leaders, learning designers, ed-tech entrepreneurs, and other practitioners who aim to produce robust design knowledge that is grounded in research and practically useful as a part of diverse research and innovation projects. University and K–12 teachers who are interested in educational design and who innovate as a part of their teaching practice may also find this book useful.

In this chapter, we first review the historical and current contexts in which this book is situated. We explain and discuss our choice of key terms, highlight topical challenges and debates and introduce the structure of the book providing an overview of its sections and chapters.

Creating design knowledge in educational innovation

Historical background

The interest in design and design knowledge in education have diverse roots. Within the Continental European tradition, the beginnings of design can be traced to the 17th century. The concept of Didaktik, understood as the theory of teaching, has traceable roots in Greek philosophy, with Comenius (1592–1670) as a still notable influence. Contemporary Continental European thinking on educational design often takes its departure in the work of Klafki (1963) and/or the work of Brousseau (2002). Characteristic of these Continental Didaktik approaches is their highlighting of choice of disciplinary content as the key issue—the What of teaching and learning—and, in particular, the question of theoretical justification of such

choices—the Why (why this disciplinary content and not something else?). This discussion, in contrast, has been less prominent in the Anglo-American approaches to educational design, where the focus is on methods, activities and resources for learning—the How.

Several of the authors of this book are inspired by Continental *Didaktik* as well as by Anglo-American approaches. For this reason, several chapters advance their articulation of design knowledge beyond a sole focus on the How and also consider the interrelation with the What and the Why. This is particularly salient in the chapters on utilising computational thinking to support disciplinary learning (Chapters 15–17), found in Section III on *Design Knowledge in Practice*.

Overall, within the English-speaking world, theorising educational design knowledge is a fairly recent endeavour. Briggs et al. (1991) refer to Thorndike (1913) as a key, originating source of inspiration for educational design within the Anglo-American tradition, but locate the beginnings of the work to the mid-20th century. This line of development can be traced back to the origins of instructional design during World War II when psychologists and educators were called to develop training materials for the military sector (Dick, 1987). Such training primarily focused on complex but well-structured tasks and had to be scalable to a large number of people, who generally had the skills to follow instructions. Design, therefore, involved two main components: (1) The use of systematic instructional design procedures or models for developing instructional materials and (2) the use of diverse media to deliver instruction at a scale (Markauskaite & Goodyear, 2017; Reiser, 2001).

Design procedures or models were the critical kinds of design knowledge. While steps or stages varied across models, they generally included analysis of instructional problems, including task performance measures, and then design, development, implementation, evaluation and refinement of instructional materials, and delivery (Dick, 1987; Reiser, 2001). The initial models mainly focused on procedures—what designers need to do to design an instructional system (e.g., Branson et al., 1975, cited in Dick, 1987). More recent literature focuses on how designers must design instructional systems to *effectively* deliver instruction. Such design knowledge draws on theories and evidence about human cognition and emphasises principles, cf. Mayer's principles for designing effective instructional videos (Mayer et al., 2020).

A stronger focus on the combination of the What, Why, and How of design has emerged only over the last five decades. This line can be traced to Shulman's (1986) introduction of the concept of Pedagogical Content Knowledge as knowledge that "embodies the aspects of content most germane to its teachability" (p. 9). A more recent extension of this perspective is Technological Pedagogical Content Knowledge (TPCK), which "emphasises the connections, interactions, affordances, and constraints between and among content, pedagogy, and technology" (Mishra & Koehler, 2006, p. 1025). From the TPCK perspective, "knowledge about technology cannot be treated as context-free and […] good teaching

requires an understanding of how technology relates to the pedagogy and content" (pp. 1025–1026). While this perspective focuses on teacher knowledge, it closely relates to the perspectives that consider teaching as a design profession "not just as a practice that includes design tasks but as a design profession, where design supports the construction of both teaching/learning artefacts and professional knowledge" (Warr & Mishra, 2021, p. 12).

This perspective moves away from viewing teachers as instrumental problem solvers who use a well-defined body of knowledge to solve well-defined problems to positioning them as designers who face complexity and change, who value conflicts and other uncertainties and the need to engage in designing for learning as a part of their daily teaching innovations (Schön, 1983; Scott & Lock, 2021). From this perspective, "Teacher education should focus on developing professional knowledge through design so that this knowledge becomes creative, fluid, and adaptable, able to be modelled to the needs of particular contexts" (Scott & Lock, 2021, p. 12) and provide teachers with design knowledge products that help them engage in design work productively. The attention shifts from step-by-step models or well-defined instructional principles to kinds of design knowledge that support fluid, emerging ways of thinking and gradual collective knowledge advancement, such as repositories of design patterns (Derntl & Motschnig-Pitrik, 2010), and frameworks that acknowledge the entangled, situated and emergent nature of design for learning, such as the framework for Activity-Centred Analysis and Design (Goodyear et al., 2021). This work on collective knowledge advancement through repositories is continued in Chapters 5 and 9, while Chapter 11 pursues the idea of collective knowledge advancement through frameworks.

New critical perspectives have emerged that contest mainstream views on knowledge and knowledge creation, putting the Who of design in focus. These critical perspectives object to the current state of things where a Global North epistemology dominates. Epistemological pluralism is suggested as an alternative that engages marginalised groups—not as research objects but as actors in knowledge creation (Connell, 2019). One such critical perspective is decolonisation that seeks social justice and equity for peoples in the Global South by promoting local and Indigenous knowledges and ways of knowing (Connell, 2019). Another is feminist epistemology that redefines "who can be knowers, who can be known, and what can be regarded as 'knowledge'" (Harding, 2023, p. 91). Other critical approaches, such as postdigital research, challenge the anthropocentric perspective, to explore how non-human entities (including technology) participate in the shaping of practice (Pallitt & Kramm, 2023). Focus shifts to the interaction and interdependencies between non-human and human actors, and the more-than-human created by this entanglement; a relational ontology is adopted, which has implications for knowledge creation and ways of knowing.

It shall be interesting to see how these critical perspectives develop and impact design and design knowledge in educational innovation, and how this focus on

the Who of design will manifest in theory, methodologies, and practice. From this overview of the historical background, we turn to the definition of key concepts.

Definition of key concepts

Overall, much innovation in design for learning has been closely intertwined with advances in three areas simultaneously: (1) Media, particularly digital technologies, (2) methodological approaches for design, and (3) knowledge about how people learn. This interconnection has become even more prominent over recent years with the convergence of learning sciences, instructional design, design thinking, software engineering, learning analytics, data mining, and other fields. For example, Kolodner (2023), describing the role of the "learning engineering" field, argues, "doing a good job of designing and analysing learning experiences and solutions requires mixing and matching across practices from a variety of design approaches, including user-centered design, UX, LX, instructional design, design thinking, human-centered design, human-centered engineering design, participatory design, design justice, and probably more" (p. 319).

Two questions emerge in this context. The first question is what we mean by innovation. The Oxford Dictionary defines this term as action, "the introduction of novelties; the alteration of what is established by the introduction of new elements or forms…" (Oxford English Dictionary, 2023c). In an educational context, Cohen and Ball (2006) describe innovation in more specific terms as "a departure from current practice - deliberate or not, originating in or outside of practice, which is novel. Innovations include novel practices, tools or technologies, and knowledge and ideas" (p. 19). In this book, we use the term innovation in a more deliberate sense to describe original ways in which people respond to particular changes or challenges, such as the emergence of new technologies or the need for new skills. In educational contexts, such innovations take different shapes—from large-scale curriculum reforms to changes in classroom practices. Educational innovations usually involve the act of designing, and the focus of this book is the knowledge that is involved or can support the act of designing. We acknowledge that this understanding of innovation differs from that of research universities where innovation is linked to the commodification of knowledge and refers to "work that produces a product that someone can 'bring to market'" (Connell, 2019, p. 123).

The second question is what we mean by design. English dictionaries typically distinguish between design as a noun and design as a verb. As a noun, it would define design as a plan or scheme intended for subsequent execution (Oxford English Dictionary, 2023a). As a verb, it would emphasise an act of creating and outlining a plan for the intended purpose (Oxford English Dictionary, 2023b). These definitions often have a clear, rational focus. However, Krippendorff (2007) suggests defining design broadly as "any effort to shape if not invent the affordances for new practices of living, forms of organization, and even languages to arise" (p. 1382).

However, Goodyear and Dimitriadis (2013) argue that a broad definition is not always helpful. Firstly, this "can make it harder to see exactly what has been designed, and how the realised form of what has been designed actually functions in practice. This, in turn, makes it harder to re-use designs in other contexts" (p. 6). Secondly, rather than "implying that behaviour, activity, experience or learning can be designed […] design activity results in the creation of *things* which can influence behaviour, activity, experience and learning" (p. 6). For this reason, we define educational design as the intentional formation of things, plans, tasks, tools, interactions, etc. that shape teaching and learning practices. For a more elaborate discussion of design in educational research, see Dohn and Hansen (2018).

Theoretical foundations

Theorising educational design knowledge has two main foci. One focus is the conceptualisation of the knowledge inherent in designing for learning, that is, the knowledge that educational designers have and make use of in practice. This knowledge may be implicit, meaning that educational designers need not be able to articulate it. The other focus is the characterisation of novel knowledge products developed in research and innovation within the field of educational design. These knowledge products are explicated in the research literature and repositories of diverse design products, such as design models, design principles, and innovation strategies. A key question, in general and for this book in particular, is the relationship between these two foci: How can the existing design knowledge of educational designers be engaged in the development of novel knowledge products; how useful are the knowledge products produced by research and innovation for the professional work of educational designers; how can practice and research reciprocally inform each other; and how can this mutual informing be supported and enhanced?

Articulation of educational design knowledge—both designers' knowledge in practice and the products produced in educational research and innovation—has centred on formulating design patterns and design principles. A key issue here has been how design patterns and design principles relate to each other; and whether one is more true to practice than the other. "True to practice" is, again, to be taken in both senses: *Representative of* practice and *useful in* practice. The work by Christopher Alexander on design within architecture has been foundational in the discussion of this issue (Alexander, 1964, 1979; Alexander et al., 1977). Alexander was sceptical of principles which he found too abstract. He argued that good design is a flexible response to the demands of the situation, and that such designs can be articulated in patterns. Patterns concern recurrent problems (like building a porch for the architect or facilitating student group discussions in education) and describe a core solution the specific realisation of which can be varied indefinitely in consideration of the context. Within education, Alexander's approach has been taken up by Goodyear and colleagues (Goodyear, 2005; Goodyear & Retalis, 2010; Mor et al., 2014) who have worked on developing a pattern language for educational

design, in line with Alexander's ambitions for architecture. Alexander's ideas and arguments are discussed at length in Chapter 4.

In contrast, another strand of research on educational design has concentrated on developing design principles, arguing that such principles can guide design whilst explicating aims and means more clearly than patterns (Kali et al., 2009; van den Akker, 1999). Definitions of design principles vary, but the following definition serves to cover most approaches: *Design principles are guidelines for achieving a stated goal, aim or purpose. They specify means for the attainment hereof, often also identifying relevant educational settings and providing justificatory arguments*. For some purposes—in particular when the focus is on predicting how designs may play out in practice—design principles are also called design conjectures. This is discussed in Chapter 9.

As mentioned initially, other design knowledge products offered within educational design research are, e.g., design guidelines, design recommendations, and design frameworks. Overall, a multitude of terms are used to denote design knowledge products, and many reports on educational innovation show little theoretical grounding of or reflection on the way in which design knowledge is represented and labelled. This issue is discussed in more detail in Chapter 7. For the purpose of this book, we subsume all these different forms of design knowledge articulation under the term *principled practical knowledge* (Bereiter, 2014). A term introduced by Bereiter to cover the kind of knowledge that combines practical knowledge (know-how) with insights into why the practical knowledge works (called know-why by Bereiter). Principled practical knowledge is "explanatorily coherent practical knowledge… not necessarily constituting a testable theory, [but] meet[ing] standards of explanatory coherence" (Bereiter, 2014, p. 5).

From this outline of the theoretical foundations that underpin the creation of design knowledge in educational innovation, we turn to issues related to methodological approaches often used to create such knowledge.

Methodological approaches

In the early 1990s, a new family of approaches emerged in educational research. The turn was marked by the seminal papers published by Collins (1992) and Brown (1992) and was an attempt to overcome the shortages of the approaches that had hitherto dominated the field. One approach was basic research conducted via controlled laboratory experiments and the other was applied research taking place in educational institutions to inform the development of curricula and teaching and learning resources (McKenney, 2016). The vision was to find a research approach that was capable of bridging research and practice and that could facilitate the construction of robust knowledge relevant for and applicable to real educational contexts.

The new family of approaches was later named educational design research (McKenney & Reeves, 2012) and includes approaches such as design-based research

and design experiments. For the sake of simplicity and in line with McKenney and Reeves (2012), the term "educational design research" will be used below to refer to this new family of approaches rather than a single form of research. At the same time, we wish to emphasise that we subscribe to McKenney and Reeves' (2012) interpretation of educational design research that might differ from other conceptualisations.

The core component of educational design research is the integration of research and design cycles in which interventions (often involving new technologies) are developed, empirically tested in naturalistic settings, evaluated, and refined in response to the evaluation outcomes (McKenney, 2016). Two or more iterations are usually carried out, and studies are divided into phases to reflect the cycles and the iterative nature, e.g., analysis, design, and evaluation (McKenney & Reeves, 2012). Each phase brings with it a number of methodological issues: How do you go about analysing the practical problem that the intervention to be designed is to solve; how do you go about designing the intervention (including technologies and other resources); and how do you evaluate and derive relevant knowledge from the empirical testing?

In addition to being interventionist and iterative, educational design research is also theoretically oriented and collaborative (McKenney & Reeves, 2012). The collaborative nature of studies brings with it questions relating to "social design" (McKenney, 2016): How do you collaborate with practitioners and other stakeholders; in which phases do you involve stakeholders; and what roles are they to perform? This issue is unfolded in Chapter 10 and specific approaches are illustrated in Chapters 13, 15 and 16.

Educational design research not only has the potential to change practice via interventions but can also yield new theoretical and empirical insights that can be used to prescribe how to go about designing teaching and learning activities to support particular types of learning processes or outcomes (McKenney & Reeves, 2012), i.e. design knowledge. Thus, methodologies for creating, representing, labelling, refining, capturing, sharing, and supporting reuse of design knowledge are crucial. However, there is a lack of methods for these purposes as well as a lack of papers that report on the creation, representation and refinement of design knowledge products in a transparent and explicit manner (Hanghøj et al., 2022). It is even asserted that design-based research, e.g., has veered away from its iterative approach to gaining theoretical insights and producing robust guidelines in favour of more conventional research processes (Hanghøj et al., 2022).

Buhl et al. (2022) argue that design-based research has become too linear and deterministic, failing to incorporate the lessons learned during empirical testing in messy naturalistic settings. This means that lessons learned, especially unexpected ones, are not always used to refine, expand or discard (some of) the design knowledge that was developed in the first part of a study to guide the design of interventions (Hanghøj et al., 2022). Further, not all practical educational innovations that produce valuable design knowledge take the form of educational design research—doing three iterations could be unfeasible in a design project that aims to

solve a practical issue rather than advance theory or explore and understand current practices. Methods for capturing design knowledge from such studies are rarely discussed, making this work more opaque and less robust. In Section II, we unfold and reflect on these methodological issues to examine current practices as well as to identify and discuss challenges.

Design knowledge in practice

The turn in educational research, described above, meant the replacement of controlled laboratory studies involving careful selection and testing of variables with the design and testing of interventions in "messy situations of actual learning environments" (Collins et al., 2004, p. 19). The introduction of naturalistic contexts and real-world settings as the place of research made *practice* central to the creation, testing, and reuse of design knowledge. Practice is described as "messy" because multiple activities and interactions are happening simultaneously in an educational setting that is often complex, dynamic, and novel. Conducting educational design research in the face of such variation and uncertainty poses challenges because the messy practice makes data collection, analysis, and reporting a complex affair.

Additionally, educational design research often produces idealised descriptions of design principles rather than relevant and robust guidelines for educators and researchers to reuse and further test in their own practices. This is in part due to the limited examination and description of contexts when evaluating and reporting on interventions and any design knowledge created (Barab & Squire, 2004). Often, practice becomes a black box that is neither problematised nor examined which leads to underspecified theories and design knowledge that is hardly useful or comprehensible beyond the participants' own setting (Hanghøj et al., 2022).

Furthermore, there can be a tendency to decontextualise design principles from the contexts in which they were generated to universalise them and scale their potential applicability. This can detract from the practical usefulness of design knowledge because information regarding the settings and conditions under which this design knowledge is applicable is missing. Thick descriptions of practice are needed in reports on the creation of design knowledge to make this knowledge comprehensible, robust, and credible, thus enhancing its practical usefulness and promoting reuse.

The chapters in Section III each report on the creation of design knowledge but establish different foci with Chapters 16 and 17 delving into the representation and refinement of design knowledge, and Chapters 13–15 taking up issues relating to co-design processes. Co-design constitutes another important aspect of design knowledge in practice. Practice-based approaches to constructing design knowledge shift the dynamics of who participates in design research, and the distribution of power and roles in knowledge co-construction processes. Recent thinking about educational innovation and design knowledge commonly emphasises participatory, human-centred design that encourages the involvement of students, teachers, and

others working together in equitable ways to design viable solutions to complex educational challenges. As Scott and Lock (2021) argue, "today's classrooms are deeply complex spaces that require teachers to approach instructional design with a deep attunement and responsiveness to the needs and lived realities of those they are designing for" (p. 3). However, such attunement and responsiveness might be difficult to achieve in conventional researcher-practitioner relationships.

Expert knowledge is often held by the researcher, not the practitioners (Anderson & Shattuck, 2012) which demands further consideration of how researchers and practitioners as collaborators can more closely work together in joint enterprise (Bannan et al., 2016; Reeves et al., 2005). In addition, such collaborations bring with them a focus on the design process itself as the object of study, analysis, and reporting to promote transparency and add detail to the creation of design knowledge. Chapters 13 and 15 in Section III reflect on ways of co-constructing design knowledge in practice, illustrating novel examples of co-design partnerships involving different stakeholders. Chapter 14 seeks to develop attunement with teachers as co-designers by investigating their experiences of a co-design initiative.

We have now explored current theoretical, methodological, and practical issues relating to the creation, representation, and (re)use of design knowledge. Below, we highlight some topical challenges and debates.

Challenges and debates

Creating design knowledge in educational research and innovation is a complex field full of questions, debates and half-solved challenges. Is this a domain of individual or collaborative practices? Can design for learning actually be separated from teaching practices? How can inherent tensions between researcher, designer and teacher agency be resolved when the knowledge at stake needs to be robust yet inclusive to different voices and actionable? How much do researchers', designers' and other participants' identities and positionalities matter?

It is not uncommon to hear that design principles, patterns, and other external design knowledge representations primarily matter when people design in teams. However, this view inevitably overlooks the diversity of needs for design knowledge and the diversity of opportunities to create design knowledge useful for others. For example, individuals who engage in small-scale innovations also look for design knowledge (e.g., remember a desperate search for design tips and tricks in the early months of COVID-19 lockdowns). Educational researchers who explore successful (and less so) educational practices have opportunities, yet need to find robust ways, to produce design knowledge. Of course, collaborative knowledge building and gradual advancement of design knowledge are ideals that educational design communities should pursue, but these practices should co-exist with other ways of creating design knowledge.

As mentioned above, a characteristic of educational design research is the involvement of practitioners in the design and evaluation of educational interventions.

More radical collaborative research approaches in which stakeholders are invited to engage as equal partners in co-creation are becoming increasingly popular as a method to enhance problem-solving, not only in education but also in other private and public sectors (Bager et al., 2022). Adopting participatory approaches can help support the development of innovative solutions that provide alternatives to prevailing views regarding how to handle, e.g., sustainability issues and other wicked problems that we face today (Bager et al., 2022). Participatory ideals and methods revolve around giving participants a voice so that power dynamics among those involved are transformed creating ownership and more symmetric relationships. Dissensus, pluralism, and conflicting interests are celebrated as sources of creativity and innovation; however, the challenge is how to implement participatory ideals and methods in an often complex and messy practice (Bager et al., 2022). It is not easy to ensure the epistemic integrity and robustness of the produced design knowledge.

In an educational design research context, McKenney (2016) discusses the roles that must be performed in researcher-practitioner collaborations and suggests how these can be distributed between researcher and practitioner. The list of roles is extensive and there are suggestions as to the roles practitioners can play in all phases of educational design research. It is clear though that it is the researcher who is in charge of the study which suggests inequitable participation. It remains an issue how genuine polyvocal and democratic engagement (Bager et al., 2022) can be realised. This would require a high degree of dialogic engagement of participants (Bager et al., 2022), rather than solely involving participants as, e.g., objects of study, interviewees, co-designers or facilitators of interventions. Critical reflexivity and transparency are needed with regard to how researcher-participant relationships are framed, how roles are distributed (or perhaps rather co-created) and how democratic, epistemically transparent, dialogue is supported, among other things.

Another topical issue is how to conduct studies that have an effect outside and beyond the project that funded it, i.e., how to enhance the sustainability and scalability of empirical, methodological, and theoretical contributions (Buhl et al., 2022). There is a need for a more critical-constructive approach to educational design research studies that involves increased awareness, reflection and transparency in relation to theory and methods as well as practice, the latter including both the context of the study and the context of implementation after project termination. This book seeks to offer theoretical, methodological as well as empirical contributions to meet the needs for increased awareness, reflection, and transparency. Below follows an overview of the contents and structure.

Structure of the book

The three main sections of the book focus on each their aspect of design knowledge: Theoretical foundations, methodological approaches and design knowledge in practice. Each section is composed of four to five main chapters that explore the

section topic and one commentary chapter that challenges, debates, and extends the ideas introduced in the section. In addition to making section-specific points, the commentary chapters unite in raising issues of equity and sustainability and discussing the significance of these issues for the section topic and how they must be taken into account. The fourth and final section focuses on synthesis and future directions.

Section I. Theoretical foundations

This book seeks to offer theoretical, methodological as well as empirical contributions to meet the needs for increased awareness, reflection, and transparency. The overall question for Section I is *What is design knowledge?* In answering this question, the section's five chapters address both of the foci outlined above, and not least their interrelation: *What knowledge do educational designers have and make use of in practice?* And *How can we characterise the design knowledge products produced in educational research and innovation?* The chapters concentrate on the two most salient forms of research products, namely patterns and principles.

Chapter 2 queries the usefulness of design principles for educational designers and points to the need for anchoring the principles in the designers' situated agency. Chapter 3 analyses design principles as communication—with text, context, and subtext—and thus as a phenomenon that both speaks to and reflects educational design practice. Returning to the ideas of Alexander (cf. above), Chapter 4 argues for design patterns as a more situated and practice-based approach to design knowledge, but also stresses the need for design principles, which have a use in critiquing patterns. The focus of Chapter 5 is on how design principles can become more accessible and useful to educational designers, if they are synthesised formally, utilising computational semantics. Initial formalising steps are provided. The section's final commentary, Chapter 6, points out that educational design is a shared activity where practitioners often have diverse disciplinary backgrounds. This necessitates articulating and discussing underlying values. Higher principles of equity and sustainability are indispensable in educational design for the future.

Section II. Methodological approaches

The five chapters in Section II examine and exemplify current methodological practices and discuss topical issues relating to the question: *How is design knowledge created, represented, refined, shared, and reused*? Chapter 7, reporting on a literature review, offers insight into the terminology used to label design knowledge and provides an overview and discussion of current methods for creating such knowledge. Chapter 8 presents and reflects on a specific method for creating, representing, refining, and facilitating the reuse of design principles, drawing on a case study that investigates how to foster shared epistemic agency in undergraduate collaborative projects. Representation and reuse is also in focus in Chapter 9 that builds on conjecture mapping to examine how to develop a digital infrastructure

for capturing and sharing design knowledge. The chapter highlights the importance of contextual information to support usefulness and reusability.

Chapter 10 moves the focus to those engaging in design and discusses how a more equitable distribution of agency between researchers and practitioners can be achieved. The chapter uses examples from an empirical project investigating how computational thinking can be meaningfully implemented in Danish kindergarten. Chapter 11 returns to the reuse of design knowledge and investigates how to support practitioners in understanding, assessing, and applying design principles for the development of writing instructions in school. The chapter proposes a framework to this end.

The five chapters are followed by a commentary that discusses the nature, role, creation, and mobilisation of design knowledge as well as agency and legitimacy. A pedagogically grounded design language, a digital platform with shared access and learning design patterns are needed to successfully engage practitioners in collective design knowledge advancement.

Section III. Design knowledge in practice

The third section of the book provides examples of how design knowledge is created, represented and used in practice. The chapters in the section are guided by the two questions: *How is principled practical knowledge for design created, represented, and used in diverse educational research and innovation projects? How do researchers, practitioners, students, and other stakeholders collaborate to create and represent design knowledge?*

Chapter 13 reports on a relational design approach that was used to involve postgraduate students in equitable co-design processes to create design principles for interdisciplinary learning in higher education. Chapter 14 turns towards university teachers' perspectives, reporting on their experiences of developing prototypes in co-design workshops. Chapter 15 highlights the complexity of balancing researcher involvement in practitioner-led design processes and reflects on the situated nature of design principles and their usability. The example used in the chapter is four high school teachers' development of learning activities to integrate computational thinking in biology and chemistry. Chapter 16 discusses the strengths and weaknesses of a theoretical and challenge-based approach to the development of design principles to support the integration of computational tools in humanistic subjects in higher education.

Chapter 17 shows how conjecture mapping can be used as a technique to support the development of pedagogical designs and illustrates how unexpected outcomes and failures can be productive for the continuous refinement of design knowledge in practice. The chapter uses as an example, a pedagogical design that was to support primary school students' development of computational literacy through writing activities in L1 classes. The section concludes with a commentary chapter that reflects on forms of partnerships in co-creation processes, different

modes of collaboration and how agency and power play out in partnerships between students, teachers, and researchers.

Section IV. Synthesis and future directions

The final section of the book contains two commentaries and a concluding chapter that seek to answer the questions: *What are the next steps to move the field forward? What are the blind spots? How could other perspectives help extend current work and produce more impactful and scalable principled practical knowledge for educational design*?

Peter Goodyear's commentary (Chapter 19) discusses questions that cut across different chapters and serve as stepping stones for future work. His main insight is that educational innovation is usually a complex, collective, and cumulative practice, and hence, the building of design knowledge should be an incremental, community endeavour.

Nicola Pallitt's commentary (Chapter 20) reflects on some critical aspects of the ideas presented in the chapters. Her main focus is on how researchers engage with practitioners in educational research and innovation projects, pointing out the need to engage more explicitly with each other's (and our own) positionalities and values.

Finally, the concluding chapter brings together critical ideas from the book and highlights future directions. The chapter emphasises that design knowledge is principled practical knowledge for design, and the advancement of such knowledge requires engagement in practices that build upon robust theoretical and methodological foundations and the continual refinement of these foundations. It also emphasises the importance of embracing the diversity and richness of the field.

References

Alexander, C. (1964). *Notes on the synthesis of form*. Harvard University Press.

Alexander, C. (1979). *The timeless way of building*. Oxford University Press.

Alexander, C., Silverstein, M., Ishikawa, S., Jacobson, M., Fiksdahl-King, I., & Angel, S. (1977). *A pattern language: Towns, Buildings, construction*. Oxford University Press.

Anderson, T., & Shattuck, J. (2012). Design-based research: A decade of progress in education research? *Educational Researcher*, *41*(1), 16–25. https://doi.org/10.3102/0013189x11428813

Bager, A. S., Hersted, L., & Ness, O. (2022). Critical discussion on dialogic engagement and various researcher positions in research concerning co-creation and co-production. *Academic Quarter | Akademisk kvarter* (24), 4–22. https://doi.org/10.54337/academicquarter.vi24.7247

Bannan, B., Cook, J., & Pachler, N. (2016). Reconceptualizing design research in the age of mobile learning. *Interactive Learning Environments*, *24*(5), 938–953. https://doi.org/10.1080/10494820.2015.1018911

Barab, S., & Squire, K. (2004). Design-based research: Putting a stake in the ground. *The Journal of the Learning Sciences*, *13*(1), 1–14. https://doi.org/10.1207/s15327809jls1301_1

Bates, A. W. (2022). *Teaching in a digital age: Guidelines for designing teaching and learning* (3rd ed.). Pressbooks. https://pressbooks.bccampus.ca/teachinginadigitalagev3m/

Bereiter, C. (2014). Principled practical knowledge: Not a bridge but a ladder. *Journal of the Learning Sciences*, *23*(1), 4–17. https://doi.org/10.1080/10508406.2013.812533

Branson, R. K., Rayner, G. I., Cox, L. J., Furman. J. P., King, F. J., & Hannum, W. H. (1975). *Interservice procedures for instructional systems development*. US Army Training and Doctrine Command.

Briggs, L. J., Gustafson, K. L., & Tillman, M. (1991). *Instructional design: Principles and applications*. Educational Technology Publications.

Brousseau, G. (2002). *Theory of didactical situations in mathematics: didactique des mathématiques, 1970-1990*. Kluwer Academic Publishers.

Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences*, *2*(2), 141–178. https://doi.org/10.1207/s15327809jls0202_2

Buhl, M., Hanghøj, T., & Henriksen, T. D. (2022). Reconceptualising design-based research. *Nordic Journal of Digital Literacy*, *17*(4), 205–210. https://doi.org/10.18261/njdl.17.4.1

Cohen, D. K., & Ball, D. L. (2006). Educational innovation and the problem of scale. In B. Schneider & S. McDonald (Eds.), *Scale-up in education, v 1: Ideas in principle* (pp. 19–36). Rowman & Littlefield.

Collins, A. (1992). Toward a design science of education. In E. Scanlon & T. O'Shea (Eds.), *New directions in educational technology* (pp. 15–22). Springer. https://doi.org/10.1007/978-3-642-77750-9_2

Collins, A., Joseph, D., & Bielaczyc, K. (2004). Design research: Theoretical and methodological issues. *The Journal of the Learning Sciences*, *13*(1), 15–42. https://doi.org/10.1207/s15327809jls1301_2

Connell, R. (2019). *The good university. What universities actually do and why it's time for radical change*. Zedbooks.

Cumbo, B., & Selwyn, N. (2022). Using participatory design approaches in educational research. *International Journal of Research & Method in Education*, *45*(1), 60–72. https://doi.org/10.1080/1743727X.2021.1902981

DBR Collective (2003). Design-based research: An emerging paradigm for educational inquiry. *Educational Researcher*, *32*(1), 5–8. https://doi.org/10.3102/0013189X032001005

Derntl, M. and Motschnig-Pitrik, R. (2010). 13. The practitioner's perspective on design patterns for technology-enhanced learning. In P. Goodyear & S. Retalis (Eds.), *Technology-enhanced learning: Design patterns and pattern languages* (Vol. 2). Sense Publishers.

Dick, W. (1987). A history of instructional design and its impact on educational psychology. In J. A. Glover & R. R. Ronning (Eds.), *Historical foundations of educational psychology* (pp. 183–202). Springer.

Dohn, N. B., & Hansen, J. J. (2018). Design in educational research – clarifying conceptions and presuppositions. In N. B. Dohn (Ed.), *Designing for learning in a networked world* (pp. 25–47). Routledge.

Goodyear, P. (2005). Educational design and networked learning: Patterns, pattern languages and design practice. *Australasian Journal of Educational Technology*, *21*(1), 82–101. https://doi.org/10.14742/ajet.1344

Goodyear, P., Carvalho, L., & Yeoman, P. (2021). Activity-centred analysis and design (ACAD): Core purposes, distinctive qualities and current developments. *Educational Technology Research and Development*, 69(2), 445–464. https://doi.org/10.1007/s11423-020-09926-7

Goodyear P., & Dimitriadis Y. (2013). In medias res: Reframing design for learning. *Research in Learning Technology*, *21*. https://doi.org/10.3402/rlt.v21i0.19909

Goodyear, P., & Retalis, S. (Eds.). (2010). *Technology-enhanced learning: Design patterns and pattern languages*. Sense Publishers.

Hanghøj, T., Händel, V. D., Duedahl, T. V., & Gundersen, P. B. (2022). Exploring the messiness of design principles in design-based research. *Nordic Journal of Digital Literacy*, *17*(4), 222–233. https://doi.org/10.18261/njdl.17.4.3

Harding, N. (2023). Chapter 6: Locating our research within feminist philosophies and epistemologies. In S. Katila, S. Meriläinen, & E. Bell (Eds.), *Handbook of feminist research methodologies in management and organization studies*. Edward Elgar Publishing Limited. https://doi.org/10.4337/9781800377035.00013

Kali, Y., Levin-Peled, R., & Dori, Y. J. (2009). The role of design-principles in designing courses that promote collaborative learning in higher-education. *Computers in Human Behavior*, *25*(5), 1067–1078. https://doi.org/10.1016/j.chb.2009.01.006

Klafki, W. (1963). *Studien zur Bildungstheorie und Didaktik*. Beltz.

Kolodner, J. L. (2023). Learning engineering: What it is, why i'm involved, and why i think more of you should be. *Journal of the Learning Sciences*, *32*(2), 305–323. https://doi.org/10.1080/10508406.2023.2190717

Krippendorff, K. (2007). The cybernetics of design and the design of cybernetics. *Kybernetes*, *36*(9/10), 1381–1392. https://doi.org/10.1108/03684920710827364

LeMahieu, P. G., Nordstrum, L. E., & Potvin, A. S. (2017). Design-based implementation research. *Quality Assurance in Education*, *25*(1), 26–42. https://doi.org/10.1108/QAE-11-2016-0077

Markauskaite, L., & Goodyear, P. (2017). *Epistemic fluency and professional education: Innovation, knowledgeable action and actionable knowledge*. Springer.

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

McKenney, S. (2016). Researcher–Practitioner collaboration in educational design research: Processes, roles, values, and expectations. In M. A. Evans, M. J. Packer, & R. K. Sawyer (Eds.), *Reflections on the learning sciences* (pp. 155–188). Cambridge University Press. https://doi.org/10.1017/CBO9781107707221.008

McKenney, S. E., & Reeves, T. C. (2012). *Conducting educational design research*. Routledge. https://doi.org/10.4324/9780203818183

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

Mor, Y., Mellar, H., Warburton, S., & Winters, N. (Eds.). (2014). *Practical design patterns for teaching and learning with technology*. SensePublishers. https://doi.org/10.1007/978-94-6209-530-4

Oxford English Dictionary (2023a). Design, N., Sense I.1. (September 2023). *Oxford English Dictionary*. Oxford University Press. https://doi.org/10.1093/OED/8944083446

Oxford English Dictionary (2023b). Design, V., Sense II.8.b. (December 2023). *Oxford English Dictionary*. Oxford University Press. https://doi.org/10.1093/OED/1602314758

Oxford English Dictionary (2023c). Innovation, N., Sense 1.a. (July 2023). *Oxford English Dictionary*. Oxford University Press. https://doi.org/10.1093/OED/4455287620

Pallitt, N., & Kramm, N. (2023). Beyond a 'Noticing Stance': Reflecting to expand post-digital positionalities. In P. Jandrić, A. MacKenzie, & J. Knox (Eds.), *Constructing post-digital research: Method and emancipation* (pp. 23–38). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-35411-3_2

Reeves, T. C., Herrington, J., & Oliver, R. (2005). Design research: A socially responsible approach to instructional technology research in higher education. *Journal of Computing in Higher Education*, *16*(2), 96–115. https://doi.org/10.1007/bf02961476

Reiser, R. A. (2001). A history of instructional design and technology: Part I: A history of instructional media. *Educational Technology Research and Development*, *49*(1), 53–64. https://doi.org/10.1007/BF02504506

Rizzuto, M. (2017). Design recommendations for self-paced online faculty development courses. *TechTrends*, *61*, 77–86. https://doi.org/10.1007/s11528-016-0130-8

Sandoval, W. A. (2004). Developing learning theory by refining conjectures embodied in educational designs. *Educational Psychologist*, *39*(4), 213–223. https://doi.org/10.1207/s15326985ep3904_3

Schön, D. A. (1983). *The reflective practitioner: How professionals think in action*. Basic Books.
Scott, D., & Lock, J. (2021). *Teacher as designer*. Springer. https://doi.org/10.1007/978-981-15-9789-3
Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. *Educational Researcher*, *15*(2), 4–14.
Thorndike, E. L. (1913). *Educational psychology: The psychology of learning* (Vol. 2). Teachers College Press, Columbia University.
van den Akker, J. (1999). Principles and methods of development research. In J. van den Akker, R. M. Branch, K. Gustavson, N. Nieveen, & T. Plomp (Eds.), *Design approaches and tools in education and training* (pp. 1–14). Springer.
Warr, M., & Mishra, P. (2021). Integrating the discourse on teachers and design: An analysis of ten years of scholarship. *Teaching and Teacher Education*, 99, 103274. https://doi.org/10.1016/j.tate.2020.103274