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How can educational research support practice at scale? Attending to educational designer needs

Susan McKenney[a,*] and Christian D. Schunn[b]
[a]*University of Twente, Enschede, the Netherlands;* [b]*University of Pittsburgh, PA, USA*

Curricula, assessments and teacher professional development programmes wield a powerful influence on teaching and learning enactment. Together with the interpretation of those using them, these products mediate the flow of ideas from research to practice. In most countries, those curricula, assessments and professional development programmes that become widely used are created by educational designers. Given their crucial function, it is surprising that the role of educational designers is rarely recognised in the educational research literature, studied empirically or supported in practice. This article argues that educational research stands to (better) support practice at scale when it is attuned to the needs of educational designers. First, mechanisms for knowledge production and use are discussed, including the linkage role played by educational designers in the educational infrastructure of most countries. Then, the importance of understanding and bolstering the linkage between research findings and the work of designers is discussed. Arguments are given for research to better support those who design for scale, along with sample research questions posed by educational designers. In these, a distinction is made between the knowledge designers crave to shape their products (curricula, assessments, teacher professional development) and the knowledge they need to shape the processes through which those products come to fruition. This article closes with a call for educational researchers to explicitly focus their knowledge creation and dissemination efforts towards research consumers with the largest direct effects on teaching and learning: educational designers.

Keywords: educational designer; curriculum; teacher professional development; assessment

Knowledge production and sharing

'Educational research is, after all, never simply research *on* education but always in some sense also research *for* education. But... there are different ways in which the gap between research and practice can be bridged' (Biesta, 2007, p. 299, emphasis in the original). Many of those who have wrestled with this question appear to operate from the stance that this relationship should be direct and that communication between research and practice should be improved. Indeed, there is little doubt that educators' direct use of research has been limited (Burkhardt & Schoenfeld, 2003; McIntyre, 2005), though recent research suggests this is changing (Penuel *et al.*,

*Corresponding author. ELAN, Department of Teacher Professional Development, University of Twente, 5 Drienerlolaan, 7522 NB Enschede, the Netherlands. Email: susan.mckenney@utwente.nl; Twitter: @SusanEMcKenney

2017). While educational researchers express frustration that their findings are rarely used to inform practice (Pieters & De Vries, 2007), educators doubt the accessibility, clarity and usefulness of scientific research (Broekkamp & Van Hout-Wolters, 2007). Often, this gap in the use of research findings is attributed to the level of accessibility of research outputs to non-academic audiences (Hemsley-Brown & Sharp, 2003), or their lack of attunement to the varied needs of educators (Neal *et al.*, 2018). Traditionally, there have also been fundamental differences in how researchers and practitioners validate and use research outputs (Bartels, 2003). Thus, an important consideration related to the research–practice gap pertains to how (research-generated) knowledge is shared.

To address the knowledge-sharing issue, educational researchers have begun advocating for modes of enquiry that feature co-creation and organic diffusion of knowledge (Finnigan & Daly, 2014; Sargent, 2014; Zeichner *et al.*, 2015). Such modes include design-based research (Bauer & Fischer, 2007; McKenney & Reeves, 2019) and design-based implementation research (Penuel *et al.*, 2011; Stosich *et al.*, 2017). Both of these modes share the dual aims of (1) deriving new knowledge and (2) building collaborative relationships between researchers and educational practitioners during the iterative design and implementation of durable solutions to real-world problems. Further, co-creation of knowledge is also visible when researchers and educators work together to understand and improve existing practice through knowledge sharing in professional learning communities. These typically feature iterative cycles of planning, observation and reflection focused on either classroom instruction (e.g. Kolodner *et al.*, 2003; Horn & Kane, 2015) or the broader educational context (Bryk *et al.*, 2011; Akkerman & Bruining, 2016). While these approaches are laudable and often effective, they are difficult to scale because each research team can only work directly with so many educators. Further, with the exception of research–practice partnerships (Coburn & Penuel, 2016), they also rarely live on past the lifecycle of single projects. *How, then, can educational research sustainably impact practice on a large scale?*

To consider this question, we first examine the existing connections between research and practice. Because we are interested in impact at scale, we do not discuss the many kinds of connections that are possible. Rather, we portray the connections that are representative for most educational systems around the globe. We focus on large-scale change because this continues to be a fundamental struggle for educational systems worldwide, as is the case when national and regional agencies push for instructional reform (Hopkins & Woulfin, 2015). In so doing, we briefly turn to scholarship on mechanisms through which scientific research knowledge is generated and shared (e.g. Nutley *et al.*, 2007). There we see that research–practice interaction is more often indirect than direct.

Research, development and diffusion

For decades it has been recognised that by far the most dominant mechanism is research, development and diffusion (RDD) (cf. Blakely *et al.*, 1987; Posner, 2004; Dearing *et al.*, 2015). RDD is based on the notion that researchers deliver knowledge, intermediaries translate this knowledge into usable products disseminated for practice and professionals use knowledge in the form of specific products. Most research-

based curricula, assessments and teacher professional development programmes result from the RDD mechanism. This mechanism aligns well with reward systems in academia (Van Looy *et al.*, 2006). And, because it involves professionals with specialised skills for tackling the challenges of application and dissemination, RDD is a viable mechanism for yielding impact at scale.

It should be noted that RDD describes the process through which research findings are made accessible to practitioners. As such, RDD must be seen as separate from the messages embodied in the products that it diffuses. For example, the same RDD mechanism that has been used to deliver educative curricula which support teachers in asserting their professional autonomy to customise engaging experiences for their learners has also been used to deliver prescriptive curricula that prioritise implementation fidelity over professional judgement. While the nature of the messages embodied in curricula, professional development and assessments warrants discussion, the RDD delivery mechanism has demonstrated its power to impact practice at scale.

Havelock (1971) published a landmark report on the dissemination and use of scientific outputs. In his work, which included attention to productive RDD, he stressed the crucial role of linkage. At that time, products created through RDD were criticised for treating teachers as passive consumers, for allowing limited opportunities to make contextualised modifications and for the underlying assumption that innovations would automatically be adopted (Schumacher, 1972; Gottschalk *et al.*, 1981). However, more recent investigation of RDD processes shows otherwise. For example, Pareja-Roblin and McKenney (in press) found that recent educational RDD projects regularly attend to active involvement of consumers (e.g. teachers being invited to participate in development teams), aim to support local adaptations (e.g. using formative evaluation data to provide customisation options for the diverse needs, expectations and background of potential users) and work to render innovations appealing and practical (e.g. tested by offering educators opportunities to see and explore specific solutions through live demonstrations). Increasingly, research reveals the critical importance of local educational infrastructure for the dissemination of reform initiatives at scale (Spillane *et al.*, 2018), as well as (inter)national networks for supporting teachers (Looi *et al.*, 2015). Thus, rather than being a strictly linear process, RDD in education today is more aptly characterised in terms of the presence of and interaction between different groups of professionals with specialised expertise related to research, development or diffusion.

Educational designers and the RDD infrastructure

Educational designers constitute crucial linking pins in the RDD process. They are professionals who work to create, redesign or curate curricula, assessments and teacher professional development. They work at non-profit standalone institutions (e.g. EDC, BSCS, National Geographic, ETS, College Board), institutes within universities (e.g. Lawrence Hall of Science at UC Berkley and the Shell Centre at the University of Nottingham), government organisations (e.g. national institutes of education or curriculum, regional resource centres and labs) and for-profit companies (e.g. Pearson, McGraw-Hill, Springer, Amplify, Carolina, Cambridge University Press). Interestingly, not all doing so would necessarily describe their profession as that of a

designer. In part, this is because job categories sometimes have other labels (e.g. curriculum specialist or assessment specialist). But it can also have to do with the fact that very few of those who engage in educational design have come to that work

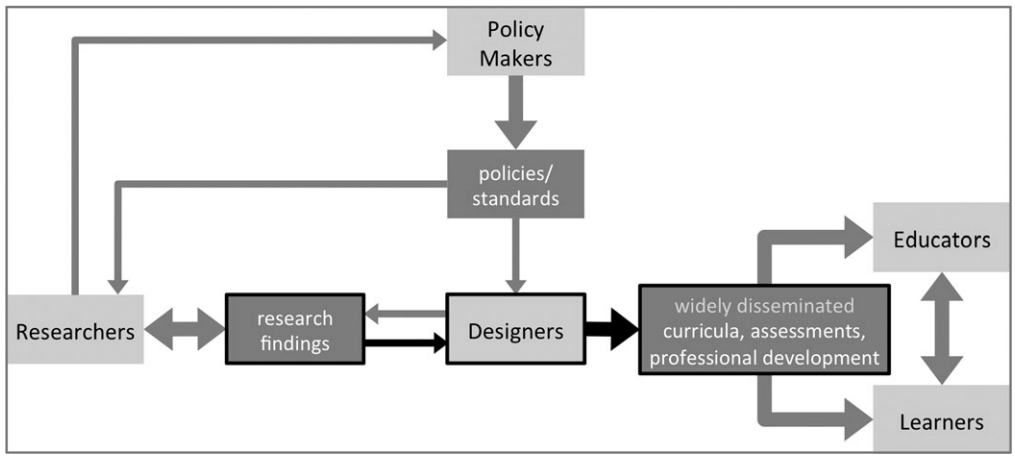

Figure 1. Key actors and products in the currently typical infrastructure for educational research, development and diffusion. Actors are in light grey and products are in dark grey; arrow thickness represents connection strength

through formal training in design. Rather, educational designers often become involved with design because of expertise they can contribute from various roles such as science educator, mathematics teacher trainer or assessment specialist.

The linking role of designers in the educational RDD infrastructure found in most countries today is shown in Figure 1. This figure distinguishes between three main groups of actors (researchers, policymakers and designers) and highlights the RDD chain that brings curricula, assessments and professional development to educators and learners. In the following discussion, we first examine the RDD products that directly influence practice, as well as products that touch practice more indirectly (policies and research findings). Then, we discuss the key actors and the interaction between them, which brings RDD products to fruition.

RDD products supporting instruction directly

In addition to being strongly affected by each other, teachers and learners are directly affected by three kinds of RDD products that drive and support instruction. First, *curricula* provide powerful subject matter and pedagogical guidance to teachers, as well as opportunities to learn (Davis & Krajcik, 2005; Shawer, 2010). By curricula, we mean resources designed for use by teachers in the classroom to guide their instruction, including textbooks, supplementary units or modules and instructional media (Remillard *et al.*, 2014). Second, *assessments* have enormous influence on teaching and learning, as teachers give high priority to classroom activities that prepare students to perform well on tests (Black *et al.*, 2012). Here, the use of the term

'assessment' refers to any information gathering relative to specific competencies and other attributes (Shute & Kim, 2014), for formative, summative or diagnostic purposes, collected by no-, low- or high-stakes approaches. Third, *professional development programmes* help teachers enhance their knowledge and develop new instructional practices, both of which are essential for responding to new demands and improving education (Borko, 2004). While informal learning is extremely important for all professions, including educators (Kyndt *et al.*, 2016), the professional development programmes referred to here are planned. These formalised learning opportunities include, amongst others, courses, workshops, learning communities and coaching.

RDD products supporting instruction indirectly

Two other kinds of products influence instruction less directly. *Policies*, defined broadly as rules and guidelines issued by schools, states and national bodies concerning any aspect of teaching and learning (e.g. class size, teacher certification), can affect teaching and learning (e.g. class size; Biddle & Berliner, 2008). Yet most policies wield influence on practice indirectly, through their manifestation in curricula, assessments and professional development. For example, teachers may read about standards, but their day-to-day practice is most commonly influenced by the work of designers, who translate standards into curriculum materials, assessments and professional development. Similarly, *research findings* can touch practice by influencing policy (Levin, 2004), but are more likely to do so through influence on the design of curricula, assessments and professional development opportunities.

RDD actors and domains of influence

The three kinds of RDD products affecting teaching and learning (curricula, assessments and professional development) are controlled by various actors in the educational system, at varying levels of distance. While there are many actors (including parents, industry and political action groups), three actors are particularly noteworthy, each with a primary domain of influence (see Figure 1). *Policymakers* in various levels of government and granting agencies create the rules and guidelines that govern education. *Researchers* produce scientific understanding relevant to understanding and improving education. *Designers* create the three kinds of RDD products that directly influence teaching and learning (curricula, assessments and professional development). Note that we describe here actor roles, not individuals, as some individuals may take on multiple roles. For example, some researchers are also designers (as is the case with design-based research), but the RDD work that occurs at scale is not typically produced by such multi-role individuals.

To a lesser extent, the three main groups influence each other. Specifically, researchers are influenced by policies (e.g. funding mechanisms), which steer the kinds of results produced. Designers are also influenced by policies, such as funding mechanisms and curriculum standards. Since policymakers rarely have time to read primary research, researchers may influence policymakers more through direct engagement (e.g. participation in advisory panels) than publications.

Educational designers have strong effects on teaching and learning

While there are promising instances of educators conducting or using research to directly change instruction (Pareja Roblin *et al.*, 2014), educators rarely have the time required to translate research findings into effective instructional products, including their (relatively brief) lesson planning time. In addition to having little time to do design work themselves, they also lack time or resources to widely disseminate their work. Similarly, while some researchers create the kinds of RDD products described here, few are positioned to disseminate at scale, or maintain their products beyond proof-of-concept testing or field trials. And while policymakers create policies that can influence curricula, assessments and professional development, they are not responsible for actually creating those products. Thus, we argue that designers are more powerfully positioned than the other two actor groups to reach the vast majority of teachers and students experiencing curricula, assessments and professional development. It then follows that, for researchers to have a broad impact on educators and learners, a good leverage case is through this smaller number of people who design educational products for large numbers of users. To do this, researchers must understand their own active participation in the RDD mechanism.

Research–designer linkage

Existing educational research is highly relevant to the work of designers, but it could be more influential if it were attuned to their needs. As shown in Figure 1, researchers primarily influence educators and learners *through* the work of designers, and this is currently the weakest link in the RDD chain. Its relative strength is influenced by both the designers' institutional goals and the affordances of specific design project structures, such as time and money to use or conduct research during design. For example, research-based design is more common amongst grant-funded designers than amongst commercial designers. Similarly, commercial design houses (whose survival is dependent on product revenue) must prioritise features that boost sales, whereas academic designers are encouraged to test or produce new theoretical understandings. But no matter the context of design, research–designer linkage could be made stronger if the research conducted better addressed the needs of designers.

Some useful research related to the work of educational designers has been undertaken. For example, the effects of final designed products have often been the subject of empirical research (Slavin *et al.*, 2012; Cheung & Slavin, 2013). This can be thought of as a kind of summative assessment. Also, the formal training (Hoadley & Cox, 2009; McKenney & Vischer-Voerman, 2013) and informal learning (Yanchar & Hawkley, 2014) of designers have been investigated previously. But to date, limited research has been undertaken to support the performance of designers. With the ultimate goal of improving the use of research insights in teaching and learning practice, the next section describes two key types of research knowledge that are urgently needed to strengthen crucial but underdeveloped research–designer linkage.

Designers need knowledge for products and processes

In this section, we elaborate the characteristics and needs of professional educational designers. (*Note:* Discussion of other groups who could, or perhaps even should, undertake design work is beyond the scope of this article.) As mentioned previously, some educational designers may have experience in research, but most educational designers have backgrounds as teachers, teacher educators or subject-matter specialists. Educational designers are employed by various kinds of organisations, including educational publishers, resource centres, institutes, schools, testing services and advisory services. These organisations, or their partners, are typically responsible for diffusion of the products created by educational designers.

While educational researchers, leaders and teachers all have longstanding training programmes, journals, and conferences focused on those roles, only recently have similar social worlds emerging for educational designers. For example, the *International Society for Design and Development in Education* (ISDDE) was formed in 2005 to help accomplished professionals raise the quality of educational materials and processes design. In particular, the goals of the society are to: improve design and development processes; build a design community; and increase the impact on educational practice. ISDDE's interests related to fostering research–designer linkage are visible in publications by a number of active members in this community (e.g. Burkhardt & Schoenfeld, 2003; Schunn, 2008; McKenney & Reeves, 2012; Donovan *et al.*, 2014). While it is a small organisation, we note that it is, to the best of our knowledge, the only organisation worldwide for professional educational designers.

We base the position presented here on our years of experience in design, as well as experiences in educating, supporting, researching and leading communities of educational designers. Specifically, the ideas presented here have grown out of: (1) extensive conversations with designers; (2) surveys conducted within ISDDE (e.g. about designer needs, conference focus preferences and desired characteristics of the society's journal, *Educational Designer*); and (3) our own experiences with teaching and studying educational design. Our experience has been that designers are especially open to consuming research, and thus will be particularly benefited by shifts in research towards supporting designers. It is likely then that researchers will have the fastest, and largest, growth in impact by focusing on these designers.

From systematic reflection on these experiences, we have identified two primary types of knowledge that educational designers regularly find inadequate or missing, whether designing curricula, assessments or professional development: knowledge to inform the designed products, and knowledge to shape and improve design (team) processes. To help inform researchers of these needs, we first overview how these needs connect to design work, along with example research areas of relevance to the educational research community. Then, in the following section, we give example research questions that designers have.

Knowledge for designed products

Designers generally crave insights that can provide sound foundations and robust refinements to the products (curricula, assessments and professional development)

that they create and/or curate. These include learning theories, design cases/principles/patterns/templates and teaching models, as well as their implications for classroom enactment, embodiment in products and the roles of teachers and learners, respectively. Designers also crave information that helps them optimise key product characteristics which inherently involve opposing tensions, such as:

- Comprehensiveness—providing adequate support vs. overburdening users.
- Flexibility—encouraging productive adaptations vs. enabling lethal mutations.
- Practicality—improving practices in diverse and resource-limited settings vs. reaching beyond the zone of proximal implementation.

Research knowledge can help designers by providing foundations, guidelines and examples that can inform core design features, key characteristics and trade-off decisions. Three broad areas of research that have the potential to be particularly relevant for designing products focus on: learning and instruction; curriculum and media; teaching and teacher learning.

Knowledge for design processes

Designers also seek knowledge to improve their own design processes. They frequently work in teams with diverse areas of expertise—which also bring challenges related to communication, intrapersonal skills, leadership and team dynamics (Barber, 2015). The processes of piloting materials also require understanding of and productive relations with field site staff, in addition to the policies and boundary conditions that govern their choices (e.g. how standards influence district control over curricula). And like researchers, designers struggle to structure, organise and carry out the empirical data-collection processes involved with analysing needs or conducting formative evaluations—especially in the midst of aggressive production schedules. Research knowledge can help designers address these challenges, especially research knowledge that focuses on: organisation and leadership; policy and social contexts; or evaluation and measurement.

What kinds of research questions do designers pose?

Organised by the types of knowledge and research focus areas named above, Table 1 presents examples of specific research questions posed by designers in relation to design products and processes, respectively. The examples chosen pertain to designing curricula, assessments and professional development. Although not highlighted in the table, the examples also point towards the diverse range of educational research that is relevant to educational design. For decades, educational researchers have been concerned with bridging the research–practice gap, and having an impact in schools (Kolodner, 1991; McKenney, 2018; Philip *et al.*, 2018). As such, the varying and hybrid perspectives of educational research stand to offer direct support for the complex task of design.

Though replication is an important element in the scientific process, researchers are typically not rewarded for examining questions like those above in more than one setting. And yet, designers find that the transfer across contexts is extremely

Table 1. Sample research questions posed by educational designers

Knowledge type	Focus area	Examples
Knowledge for designed products	Learning and instruction	*How to garner and maintain learner engagement with specific content areas at certain ages?* *Which experiences and supports help learners develop specific conceptual understanding?* *How can benefits of the 'testing effect' be harnessed in routinised formative assessments?*
	Curriculum and media	*What are guidelines for effective versus distracting features in learner workbooks, and how do these differ among ages and instruction language proficiency?* *What kinds of electronic (professional) learning environments can meet diverse community needs at scale?* *To what extent, under which conditions and with whom can they (partially) substitute for live contact?*
	Teaching and teacher learning	*How does teacher knowledge evolve over phases of teacher preparation, induction and professional development?* *How do teachers perceive their own roles in specific subject areas and specific grade levels?* *Of educative features of teacher resources, which ones are actually used? By what kinds of teachers? Under which conditions?*
Knowledge for design processes	Organisation and leadership	*How to increase and leverage diversity and mitigate conflict in heterogeneous educational design teams?* *How to stimulate development of designer knowledge, strategic intuition and creativity while designing on a tight schedule?* *How to balance the assessment designer's need for a consistent focus with the learning designer's need to adapt the focus in response to prototyping?*
	Policy and social contexts	*How to sensitise designers to policies that influence the adoption, uptake and use of their products?* *How to establish and nurture partnerships amongst coalitions of schools and of researchers in which the schools agree to serve as testbeds in exchange for supported exposure to high-quality innovations?* *How to articulate and refine designer assumptions about the nature of learning and teaching contexts?*
	Evaluation and measurement	*What evaluation approaches are more practical, valid and reliable for diverse cultural and linguistic settings?* *How can designers efficiently collect reliable data, and identify key patterns in time to redesign?* *How to efficiently measure complex outcomes?*

challenging. For less well-funded learning domains (e.g. social studies), research that addresses their core research questions is frequently limited to single investigations, proof-of-concept studies, or demonstration cases. Since designers usually create curricula, assessments and teacher professional development programmes relating to specific content and grade levels, broad gaps in the knowledge needed are highly problematic.

Creation, uptake and use of research knowledge for design

In this article, we emphasise the need for research that can inform and serve the work of educational designers, to support the design of specific products or design (team) processes; many examples are shown in Table 1. However, research–designer linkages also need to be further strengthened by investigation into enablers of and barriers to the uptake and use of research by designers. Such investigation can build on existing literature related to modes of interaction, while creating knowledge for design, as well as the uptake and use of research knowledge.

Modes of interaction

While we have argued that limited research has been undertaken to inform the work of educational designers, there is no lack of research into design processes related to other fields, especially engineering. Given that education has been referred to as a design science (Collins, 1992; Laurillard, 2012), and experts have pointed to the need for engineering approaches in education (Burkhardt & Schoenfeld, 2003; Zaritsky *et al.*, 2003), it seems fitting to consider relevant insights from research on engineering design. For example, Mehalik and Gorman (2006) identified three states of designer relationships: (1) a top-down state in which one actor has the overall mental model and other actors are put into specific roles, whose purpose they only partly understand; (2) a trading-zone state in which actors do not have to share mental models but can trade using boundary objects; and (3) a shared-representation state in which all actors share a mental model of what needs to be accomplished. Interestingly, these three states bear a resemblance to the three forms of educational researcher–practitioner cooperation identified by Wagner (1997) and still active today (McKenney & Reeves, 2019): (1) data-extraction agreements, in which both actors stay within the bounds of their formal roles and the study is designed and reported by the researcher; (2) clinical partnerships, in which the research is designed collaboratively and actors help each other achieve their separate, role-related goals; and (3) co-learning agreements, in which the goals, processes and outcomes of the enquiry are defined by both actors and evolve through action and reflection. These characterisations draw attention to the importance of (un)shared mental models, goals and responsibilities. Further, they illustrate that designers may find themselves in a variety of relationships, and in roles ranging from leader to co-learner. Existing research on modes of interaction between researchers and teachers, school leaders and intermediaries finds that co-creation of knowledge positively influences uptake and use (Vanderlinde & van Braak, 2010). We submit that the same is true for designer use of research knowledge.

Unlike teachers and schools, the work of educational designers is rarely studied. Currently, designer engagement with researchers primarily takes place through their participation in the RDD mechanism. We note that, if the work of designers is to be better supported, then other actors in this system (especially researchers but also policymakers) must understand the crucial role played by designers and attend to their needs. Further, it seems important to recognise the limitations of this positioning for designer professional development. Namely, the RDD mechanism supports the

learning of end users, not of the developers themselves. Thus, to support the learning of designers, alternative mechanisms are needed. These are discussed in the next section.

Knowledge mobilisation

Nearly a quarter century ago, the authors of *The new production of knowledge: The dynamics of science and research in contemporary societies* (Gibbons *et al.*,1994) struck a chord of recognition amongst policymakers and researchers alike with their description of how the production of knowledge and the processes of research were being radically transformed. They distinguished two forms of knowledge production, each having implications for knowledge uptake and use. Mode 1 knowledge production is primarily directed by university researchers. Within this relatively impermeable structure, specific problems and investigations are defined and vetted. The resulting knowledge is an entity, if not a commodity; it is both general and transferable. In the literature on expertise and the professions, this kind of knowledge is often referred to as propositional knowledge (Young & Muller, 2014), declarative knowledge (Stürmer *et al.*, 2013) or more simply 'know what'. The spread of Mode 1 knowledge is hierarchical and linear, from researchers (sometimes through intermediaries) to practice.

In contrast, Mode 2 knowledge production is not hierarchically organised, and the problems are defined and solved in practice. The resulting knowledge is practical and context-specific; it spreads organically. While it is often referred to as 'know how', this kind of knowledge includes more than skills alone. For example, across professions, Winch (2014) distinguishes the following aspects of know how: technique, skills, transversal abilities, project management capacity and occupational capacity. Focusing on teachers, Schoenfeld (2010) noted that, alongside the core knowledge base (propositional knowledge), professional decision making is driven by: disciplinary habits and practices; metacognition; and productive beliefs aligned with those of the discipline. The development of this kind of knowledge is highly social (Guile, 2014), and requires repeated opportunities to engage in authentic practice (Ericsson, 2006; Bransford *et al.*, 2010).

Some research–designer linkages would be characterised as Mode 1, but many are better described as Mode 2. Because both Modes 1 and 2 are important as well as common, this section examines the connections between researchers and designers, in relation to each. In both cases, we focus on how designers develop the kinds of process- and product-related conceptual understanding illustrated in Table 1. This is because (mastery of) concept understanding is crucial for transfer to professional practice, and because (mastery of) conceptual understanding critically depends upon the ways in which designers can interact with the conceptual content (Winch, 2016). In so doing, we find Levin's (2013) notion of 'knowledge mobilisation' particularly useful. The term 'knowledge mobilisation' (as opposed to translation or transfer) stresses the interactive, social and gradual nature of the bilateral linkage between research and (design) practice in the field of education. Levin's (2013) conceptualisation of the knowledge mobilisation process centres on three overlapping and interacting domains: production of research knowledge (typically

by universities and institutes); use of research knowledge (by policymakers and practitioners, as well as—we argue here—designers); and mediation of the two (by individuals, organisations and processes). Building on Levin's (2013) conceptualisation, we call for increased *mediation* between research production and research use by design practitioners, and consider implications for individuals, organisations and processes.

For *individuals*, we encourage dual citizens who are fluent with and empathetic to the goals of each community. The role of brokers and boundary crossers in the uptake and use of research knowledge by teachers and schools is well acknowledged (Daly *et al.*, 2015), and it seems plausible that this would also hold true for designers. For many researchers, this requires becoming more involved in design for scalable and sustained use (as opposed to design primarily as a complex treatment for scientific investigation). For designers, such collaboration could afford opportunities for elaborating propositional knowledge, engaging in sense-making processes (e.g. Coburn *et al.*, 2009), or developing the capacity to anticipate consequences, a crucial element of judgement.

Organisations can support the development of dual citizens and cooperation across institutions. For example, the International Society of the Learning Sciences, the British Educational Research Association or ISDDE could use their networks to facilitate co-creation of new knowledge by researchers and designers, by supporting collaborative projects, especially in the context of designing for scalable and sustained use. Also, the academic community might collaborate more actively with those who create and curate designs. This could include educational publishers (e.g. through the growing availability of summer academic internships, especially in technology divisions) and newly established teams for research-based learning design. Potentially even more broadly accessible to all researchers would be state and regional organisations that do design work, such as compiling packages of curriculum materials or creating professional development and assessments to support schools. Such efforts should target both Mode 1 knowledge production (i.e. research on and for designers), which helps develop propositional knowledge and Mode 2 knowledge production (i.e. research for and with designers), which develops various aspects of know how.

Finally, new *processes* can facilitate mediation between knowledge production and use, in both Mode 1 and Mode 2 forms. Increases in Master's programmes jointly taught by researchers and designers on learning design could offer opportunities to develop a more highly integrated research–design capacity. In addition, new or adapted funding mechanisms should be created to bolster research–designer linkage. One funding approach could feature designer collaboration with external researchers (design-based [implementation] research, research–practice partnerships). Another approach could involve special attention to designer voices in advisory boards on educational research grants. A third approach could involve specifying designers as primary audiences for dissemination in educational research grants. To date, 'practitioners' have typically been conceived of as teachers and school leaders. Yet we argue that designers constitute crucial co-creators and direct consumers of research knowledge, whose urgent needs must be met if scientific insights are to finally have large effects on practice and student outcomes.

Concluding remarks

Large sums of time, money and energy are invested in educational research each year in the hope of yielding productive outcomes for educational practice—both the grant requests for proposals and the narratives in the grant proposals emphasise this rationale for funding, as opposed to only answering interesting open scientific questions about the nature of learning. Yet the degree to which these benefits are realised can be powerfully mediated by educational designers, who produce the bulk of the curricula, assessments and professional development opportunities that directly affect great numbers of teachers and learners. Thus, strengthening and broadening the impact of educational research on educational practice inherently requires attending to the needs of educational designers.

Educational researchers have been advised to become more knowledgeable about and more capable of positioning their work in relation to large-scale political contexts, such as national or regional policymaking (Darling-Hammond, 2016). As educational researchers increasingly become cognisant of the importance of infrastructure (Penuel, 2015), it seems crucial to understand existing RDD practices and the strength or weakness of linkage, if our research is to be able to support practice at scale. Designers currently use some of the research of others, though this varies as highly as do design contexts (e.g. funded projects, site-specific development, commercial products and curated collections of existing materials). Alongside other mechanisms that foster direct connections between research and practice, we argue for some changes in approaches to knowledge mobilisation in the RDD infrastructure, through which a wide range of research could critically inform both the structure of the products that directly impact teaching and learning processes and the design processes used to optimise these products. This requires that educational researchers tend to the needs of educational designers, both in terms of producing relevant and usable knowledge, and by attending to its uptake and use. Doing so would bolster the currently weak link of research–designer connections and thereby greatly facilitate an RDD pathway with large (rather than the currently limited) impact of educational research on practice.

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