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Description

This paper argues the case for conducting theoretically well-grounded empirical research into teachers' design activities, including their design thinking, as a strategically important complement to practical development work in the field of learning design. We identify some issues arising from two related lines of empirical research in which we have been engaged – drawing attention to the importance of context in design cognition. We also introduce a conception of teachers' personal pedagogical knowledge as 'knowledge in pieces', and examine some of the implications of this view for thinking about the relationships between pedagogical beliefs, design decisions and teaching practices.

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Learning design, design contexts and pedagogical knowledge-in-pieces

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Abstract

This paper argues the case for conducting theoretically well-grounded empirical research into teachers' design activities, including their design thinking, as a strategically important complement to practical development work in the field of learning design. We identify some issues arising from two related lines of empirical research in which we have been engaged – drawing attention to the importance of context in design cognition. We also introduce a conception of teachers' personal pedagogical knowledge as 'knowledge in pieces', and examine some of the implications of this view for thinking about the relationships between pedagogical beliefs, design decisions and teaching practices.

Introduction

Research and development in the broad field of learning design - including work on learning object repositories, reuse of designs and objects, design patterns and design principles - has put significantly more effort into 'supply-side' than 'demand-side' issues. Much more attention has been paid to the development of tools, standards, software and infrastructure than to establishing what users – primarily teachers, that is – actually need. Such technology-led ventures take the risk that they will produce tools and resources that get disappointing levels of take-up, in part because the developments are based on untested assumptions about users and contexts of use. We believe that future progress in learning design R&D will require more and better research into users, their needs, contexts of use and the affordances of the various tools and resources that are meant to improve their design activity. There will have to be a more productive interaction between (a) creating and testing new tools (etc.) and (b) carrying out well-conceptualised empirical research to inform better specifications for these tools. Such empirical work is not straightforward. It is no use if it is inherently conservative – we expect the introduction of new tools to change practices and personal capabilities for the better. But neither can it ignore the social practices of design or the mental resources and constraints involved in design cognition.

In this paper, we synthesise some lessons learned from two parallel strands of empirical research on university teachers' design activity. One strand has been examining iterative improvements to the design of three university courses, and has focused on the role of design principles (Kali, Levin-Peled & Dori, 2009). The other has been investigating the evolution of a university teacher's design thinking, over a one semester course, focussing particularly on the variety of mental resources activated during design cognition (Goodyear & Markauskaite, 2009). In both study settings, the teachers' students were engaged in collaborative learning and were making extensive use of technology. In this paper, we want to (a) extend and illustrate some of the argument about the value of empirical research into teachers' design activity, (b) use this as a way of critiquing some influential assumptions about the nature of teachers' personal pedagogical theories, (c) examine some related issues concerning the role of *context* in design.

This work is part of a larger interest we have in design-based research, teaching-as-design, design principles, design patterns and pattern languages and design cognition (see e.g. Kali, 2006, 2008; Goodyear, 2000, 2005; Goodyear & Markauskaite, 2009; Goodyear & Retalis, in press). We have

come to attach particular importance to the ways in which design thinking has to move back and forth between macro, meso and micro-level considerations, and has to deal in an integrated way with at least four design components, involving tasks, people, tools and regulations. Design cognition and design practices, in the field of education, take on distinctive qualities because of the need to travel between high level pedagogical theory and the minutiae of learning activities, using various kinds and levels of intermediate representation to do so (Goodyear, 2005; Ruthven et al., 2009). We have also found that translating abstract design ideas into concrete design artefacts is a process with which many novices have difficulties (Kali & Ronin-Fuhrmann, under review).

Related research

A substantial body of research on teachers' thinking, decision-making and beliefs has emerged over the last 20-30 years. For summaries, see Clark & Peterson (1986), Calderhead (1996), Hativa & Goodyear (2002), Postareff et al., (2008). A subset of this research has focussed on teachers' planning activities (e.g. Stark, 2000; McAlpine et al, 2006; Eley, 2006). There has also been a somewhat separate line of research involving empirical studies of instructional design – sometimes involving school or tertiary education teachers, sometimes novice and expert professional instructional designers (e.g. Hoogveld et al., 2002; Kirschner et al., 2002; Ertmer et al., 2008 ,2009). Some studies link between the two by trying to assess the extent to which experienced and/or successful teachers make use of instructional design methods (e.g. Moallem, 1998; Young et al., 1998). Studies of how teachers use learning designs, design tools, design principles and design patterns are still rare (Bennett et al., 2008; Uduma & Morrison, 2007; Levy et al., 2009; Masterman et al., 2009).

There is not space here to provide a review of these studies, but we wish to draw out the following points:

1. Classic models of instructional design tend to assume a 'greenfield' site, whereas design in practice tends to be concerned with improving aspects of already existing courses; iterative review and piecemeal redesign is a better way of characterising the work than design *ab initio.*
2. Teachers with limited training in design methodology tend to jump very quickly from deciding on a learning goal to specifying the concrete details of lessons.
3. The main value of design tools and other design resources may well be to provoke teachers into thinking about new learning activities, rather than equipping them to carry out pre-existing pedagogical intentions.

An important idea emerging here is *teacher experience and design context*. To understand and help improve design activity, including design thinking, we need to understand how teachers-as-designers (re)use their experiential knowledge resources and work with context – how their attention becomes focussed on a set of local issues (while other issues move to the margins of attention).

Emerging themes in our recent research

We will introduce five related areas, before linking them to this important notion of design context. The first theme that emerges as a clear outcome from the research reported in Kali et al. (2009) is that we need to have realistically modest expectations about the role that design principles can play in real-world design processes.

Following on from this, a core challenge is to understand how teachers who are engaged in design activity actually work out what a particular design principle *means*, in the context of the design task they are currently tackling.

The third really striking aspect of the iterative design work described by Kali et al (2009) and Goodyear & Markauskaite (2009) is how the teacher-designers were able to use robust data – about student outcomes and student views on their learning experiences. Crucially, they had data that told them about learning processes and *specific* higher-level learning outcomes that were not being achieved by a significant number of the students. Such data can focus awareness and help prioritise issues for attention in the next iteration of course design. We suspect that it is all too rare for university teachers to have timely, valid and reliable data on student achievement. This is a major problem in the assessment process itself, but also handicaps any attempts at evidence-driven iterative design.

The teacher studied by Goodyear & Markauskaite (2009) - 'Sophie' – drew heavily on her perceptions of students' experiences and achievements in thinking about her next design moves. She did not always have timely access to the kind of data available to the teachers in the Kali et al. study, but she did, nevertheless, make extensive references to current, past and future students, as well as to her own learning experiences. Over a series of eight semi-structured interviews, Sophie referred to 'last year's students' dozens of times. This led Goodyear & Markauskaite to remark: "Important elements of teachers' knowledge are grounded in, perhaps even refracted by, what they perceive the students' experience to be" (op. cit., p161).

Finally, Goodyear & Markauskaite (2009) draw attention to the ways in which Sophie employed, and was able to account for, strongly contrasting pedagogical approaches in different teaching contexts – switching between exploration and knowledge-building (when the students need to understand complex concepts and relationships) and direct instruction (when they need to learn how to drive a piece of software).

Insights into the nature of personal pedagogical knowledge and implications for learning design

A major issue that needs better resolution if we are to understand the relationships between teachers' pedagogical commitments, use of technology and engagement in design is the question of whether their pedagogical beliefs are stable and coherent, or contextually-sensitive and fluid. This matters for a number of reasons. For example, talking more generally about university teachers' use of technology, Bates and Poole assert:

> '…the choice and use of technology are *absolutely dependent* on beliefs and assumptions we have about the nature of knowledge, how our subject discipline should be taught, and how students learn' (Bates & Poole, 2003, p.25, our emphasis).

Similarly, Bain & McNaught (2006) report on a number of 'complex, yet interpretable' relationships between university teachers' beliefs about teaching, learning and knowledge (on the one hand) and their uses of educational technology (on the other). While urging against oversimplification of the relationships between beliefs and practices, they nevertheless imply that beliefs are relatively stable and coherent (at the intra-individual level) and are causal – i.e. that practices flow from beliefs, rather than vice versa.

More recently, Claire Donald and colleagues (2009) have described their HEART methodology – an approach to design which is intended

> "… to help teachers and designers select and work with existing learning designs, by helping them reflect on and articulate the educational beliefs *underlying* their own and others' teaching and learning design practice." (p. 180, our emphasis).

In short, one can find quite strong views in the literature that conceive of teachers' pedagogical beliefs as coherent and foundational – constituting a kind of personal pedagogical theory used to make decisions which result in pedagogical actions (including design actions).

Knowledge-in-pieces

Our research is leading us to challenge this view, and to see it as an obstacle to the improvement of design practice (because it suggests beliefs are inflexible and constrain learning and action).

In addition to drawing on our empirical observations, our argument with a coherent, stable and foundational view of personal pedagogical theory is informed by some interesting developments in theorizing about personal epistemologies (see e.g. Hammer & Elby, 2002) and on research revealing discrepancies between teachers' conceptions of teaching and aspects of their educational activities (see e.g. Eley, 2006; Postareff et al, 2008; Foley & Ojeda, 2008; Henderson & Bradey, 2008).

Hammer & Elby (2002) argue persuasively against what they call a 'unitary theory' view of personal epistemology. They draw on diSessa's work on conceptual change in Physics (see e.g. di Sessa, 1993; 2006; also Wagner, 2006), which introduced the notion of 'knowledge in pieces' to account for commonly observed (mis)conceptions in students' Physics knowledge. According to diSessa, people's direct experiences of the physical world leads to the creation of mental resources that he calls 'phenomenological primitives' or p-prims. P-prims form a layer of knowledge between 'hard wired' direct experience and conscious concepts. They may be an individual's interpretation of an observable phenomenon, which they then use to explain that and other similar phenomena encountered in the world. P-prims are readily activated when the context is right. By extension, epistemological p-prims are created through experiences with different forms of knowledge and ways of knowing (Hammer & Elby, 2002) – they are part of how people make sense of what knowledge is.

We now want to claim a place for *pedagogical* p-prims – which are implicated in pedagogical sense-making. They encode direct experiences of learning and teaching. In principle, they provide powerful, generative, mental resources useful for sense-making and for applying more abstract conceptual knowledge. Just as p-prims arising from experience with the physical world can be implicated in 'naïve physics', so p-prims arising from experiences of being taught, or of teaching, may be the building blocks of 'folk pedagogy'. They are implicated in what might be called 'traditional teaching', formed through a process in which an individual teacher's ways of teaching are strongly shaped by their personal experience of being taught. An important explanatory advantage of this 'knowledge in pieces' view of human mental resources is that it can deal with observed inconsistencies in people's physical, epistemological and pedagogical beliefs. Different sets of p-prims are activated in different contexts. People are generally good at making sense of things in specific contexts. They are not famously good at maintaining coherence among large sets of beliefs and across diverse contexts. P-prims help explain how it is that teachers can appear to espouse contradictory pedagogical views when asked to think about different specific teaching contexts (see e.g. Eley, 2006; Postareff et al., 2008).

Context and implications for the future of learning design

We think that this perspective on personal pedagogical knowledge has a number of significant implications for thinking about how teachers (will) engage in design, and for the tools (etc) that can support their design activity. In the remaining space, we will return to knowledge integration and the role of context in design.

Instructional design models do not often draw attention to the fact that design for learning involves *balancing* competing forces and *integrating* diverse knowledge systems. For example, any one learning activity may have multiple intended learning outcomes: some may be near-term and concrete ('learn this equation') others may be longer range and more abstract ('learn to be a good team-player'). Then again, teachers' designs have to negotiate an acceptable compromise between students' wants and students' needs, and between the pedagogically ideal and the affordable. Design is intimately concerned with finding workable compromises, with resolving tensions. There is no calculus for resolving these tensions – the forces concerned cannot all be reduced to a common currency. Rather, design cognition *has to* deal with different forms of knowledge and ways of knowing; it necessarily involves the activation of mental resources that are hard to integrate. Context both helps and complicates matters. Having a specific context in mind – that is, working on a delimitable part of a larger design problem – should make it easier for relevant mental resources to be activated (c.f. Wagner, 2006). Expertise in design can be seen, in part, as the capacity to activate the mental resources that are needed by the current problem context. But local solutions have to be articulated with one another, to some acceptable degree.

One practical implication that we are now exploring is that some kinds of design aid – for example, design patterns assembled in pattern languages – take a form that would appear to be particularly handy for managing contexts. Voigt (in press) has drawn attention to the way that the hierarchical structure of a pattern language permits pedagogical design guidance to be restricted to particular contexts – an advance on trying to apply universalistic pedagogical principles. What is now ripe for further empirical exploration is the way in which specific sets of mental resources come to be activated as a teacher-designer reads and works with the patterns in a pattern language.

Concluding comment

In this paper, we have tried to sketch some issues for the future of learning design that emerge from recent empirical work and theorizing about the nature of design practices and design cognition. In particular, we have drawn attention to the significance of contexts in the design process, to some of the difficulty entailed in treating a teacher-designer's personal pedagogical knowledge as coherent, theory-like and a foundation for action, and to some of the explanatory and practical benefits that can flow from seeing personal pedagogical knowledge as 'knowledge in pieces'. Further consideration of these issues can inform practical developments in the technology of learning design as well as more fruitful empirical research into the design process.

Acknowledgements

Lina Markauskaite and Peter Goodyear would like to thank 'Sophie' for giving so much of her time to sharing insights into her design thinking. They would also like to acknowledge the financial support of the Australian Research Council, through grants LP0562146 and DP0988307, and the Australian Learning and Teaching Council. Yael Kali would like to acknowledge the National Science Foundation, which supported this work through grant ESI-0334199.

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