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Designing and researching technology enhanced learning
for the zone of proximal implementation
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Purpose

Society in general and research foundations around the globe such as the European Research Council and the (American) National Science Foundation are increasingly calling for the relevance and practical applicability of research to be made transparent. Despite intentions to the contrary, research on technology enhanced learning (TEL) that truly serves current educational practice is more rare than it is common (cf. Reeves, Herrington & Oliver, 2005). Insights on pedagogically appropriate uses of educational technology for representative teachers in everyday school settings are severely limited. In part, this is because (design) research is conducted at the bleeding edge of what is technologically possible - exploring innovative uses of new and emerging technologies. There is no disputing that such work is greatly needed to seek out new ways to potentially enhance the quality of teaching and learning. However, in the excitement of exploring what is possible, tomorrow, there is insufficient research and development work focusing on what is practical, today. This leaves a problematic gap between what could be effective TEL in theory, and what can be effective TEL in practice. With the aim of generating 'usable knowledge' (cf. Lagemann, 2002) and creating innovations that truly serve learning in practice, this paper calls for designers/researchers of TEL to devote attention to not only fine-grained issues of pupil learning and instruction, but also to broader factors that determine if and how innovations are understood, adopted and used by teachers and schools. Allowing these issues to steer the design of TEL innovations is necessary to yield innovations that can feasibly be implemented outside of (often highly enabling) research and development trajectories.

Current shortcomings of TEL (design) research

There is no shortage of literature critically assessing the educational impact of the TEL (or lack thereof), and why innovations tend to fail. Common problems in the implementation and/or maintenance of TEL innovations demonstrate that, with regularity, insufficient attention is given to anticipating and designing for educational realities. Within the classroom, common problems stem from: poor alignment between innovations and classroom curricula such as textbooks and attainment targets (Cuban, 2001); downplaying, or flat-out or ignoring system unchangables such as assessments, technology policies and infrastructure (McKenney, Nieveen & van den Akker, 2006); over-estimating the interest and expertise of teachers, not just related to technology and or (pedagogical) content knowledge, but also related to the orchestration that is often involved in giving students access to/guidance on the technology (cf. Knezek & Christensen, 2008); insufficient attention to practitioner understanding and ownership of the innovation and its underpinning ideas (cf. Tebbutt, 2000); focus on delivery and not on pedagogy (Reeves, 2011). Looking broader than classroom innovations alone, researchers at the Open University of the Netherlands identified six 'sure-fire causes of failure' for ICT innovations (OUNL, 2005). These are:
-   Lack of balance between investments and output (e.g. high investment with low output);
-   Information politics (power is abused and information is not transmitted);
-   Lack of responsibility (uncertainty about the responsibility of people inside and outside the project);
-   Culture gap (the gap between technology specialists and the rest of the organization, as well as between those the planners and enactors of education);
-   Over-commitment (not knowing when to cut losses and stop a project); and
-   All-in-one solutions (trying to do everything at once instead of using multiple projects, steps, and phases).

The shortcomings of TEL (design) research are not only measured in terms of innovation failure. They can also be measured in terms of innovation focus. Often, technology-based innovations are conceived of by good-willed technology enthusiasts, seeking to design, develop, and try out new possibilities. However, in so doing, opportunities are frequently missed to address more urgent issues in schools. This issue plagues much educational research and is especially applicable to that involving technology. The words of Schön (1995, p. 28) are applicable here:

> "In the swampy lowlands, problems are messy and confusing and incapable of technical solution. The irony of this situation is that the problems of the high ground tend to be relatively unimportant to individuals or to the society at large, however great their technical interest may be, while in the swamp lie the greatest problems of human concern. The practitioner [or in this case, designer /researcher] is confronted with a choice. Shall he remain on the high ground where he can solve relatively unimportant problems according to his standards of rigor, or shall he descend to the swamp of important problems where he cannot be rigorous in any way he knows how to describe?"

While mucking it up in the 'swampy lowlands' can certainly present methodological challenges to research, rigor and relevance are not mutually exclusive (Reeves, 2011; McKenney & Reeves, forthcoming). However, as Schön points out, commitment to relevance is a matter of choice. Given all the time, energy and resources being pumped into developing and studying educational technologies, it would seem we are behooved to identify ways to design, develop and try out new possibilities that speak not to quasi-needs (e.g. "our teachers need ideas for how to use the iPads we gave them"), but to urgent ones.

Toward relevant TEL research within the zone of proximal implementation
Much current research on TEL ultimately benefits only a small fraction of learners and practitioners, because it is conducted through high-intensity boutique projects (cf. McKenney, 2006). Such projects tend to feature substantial levels of researcher/facilitator involvement and often lack attention for gradually withdrawing implementation scaffolds or creating/shifting ownership of an innovation into the hands of those who would continue its use. As stated above, such projects are necessary, but not sufficient to develop the understanding and tools that can yield improvements in everyday practice. To seriously explore the viability and effectiveness of TEL, research is also needed that seeks to understand the perceptions, behaviors and motives that shape the varied experiences of teachers and learners in different settings. :

- *Representative/diverse teachers:* Through working with diverse and representative teachers over time, it is possible to move beyond innovative one-off pilots and study how to bring about and sustain (even modest) advancements in pedagogically appropriate uses of technology.
- *Representative/diverse, learners:* Remembering that technology constitutes a mode of delivery and not, in and of itself, pedagogy, working with different kinds of learners can yield insights into the different ways that learners respond to TEL environments and different implementation choices made by teachers.
- *Representative/diverse settings:* Rather than working around the (for researchers often frustrating) realities and limitations of classroom and school infrastructures, this view tackles head on the work in average settings where, for example: the costs of printing are prohibitive; the school's internet firewall acts more like a prison than a filter; the teachers have extremely little curricular autonomy to make decisions about when/how to integrate technology in their classes; how the location of computers (e.g. 3 in the classroom vs. 8 in the lab) plays a determining role on how things are implemented; or 'covering' the examination content almost singularly drives the allocation of learning time.

Studying the status quo of teaching, learning and settings, and designing TEL such that it gradually bridges from the current situation to the desired situation, is essential to developing both the knowledge and the tools required to address real needs in today's classrooms. This perspective is referred to here as the *zone of proximal implementation*. Vygotsky's concept of the zone of proximal development – the distance between what learners can accomplish independently and what they can accomplish through guidance or collaboration – has previously been applied to large scale reform (Rogan, 2007; Rogan & Grayson, 2003); school leadership (McGivney & Moynihan, 1972); and the mediation of educational partnerships (Oakes, Welner, Yonezawa & Allen, 1998). Similarly, others have referred to the need to pursue certain innovation goals in stepwise fashion, gradually moving from the current situation toward what is desired (cf. Sullivan, 2004). Here, the basic concept is applied to the design of TEL; but rather than focusing on what can be achieved by learners, it focuses on what can be implemented by teachers and schools. The zone of proximal implementation refers to the distance between what teachers and schools can implement independently and what they can implement through guidance or collaboration. Designing for the zone of proximal implementation means explicitly tailoring products and processes to fit the needs of not only learners, but also of teachers and schools. It additionally means planning for implementation scaffolding (e.g. honoraria or researcher co-teaching) to fade away in a timely fashion, while simultaneously developing the ownership and expertise among practitioners that will engender the desire and ability to sustain innovation. This is done, in part, through responsive (and sometimes participatory) design, fed by insights concerning learners, practitioners and context.

How to design and study TEL at the zone of proximal implementation?
In their book on conducting educational design research, McKenney and Reeves (forthcoming) identify four characteristics of innovations that are prone to successful implementation; such innovations are: value-added, clear, compatible and tolerant. During the inception, creation and testing of TEL innovations at the zone of proximal implementation, these characteristics may be considered criteria to be met. These concepts are briefly summarized below (please see McKenney and Reeves [forthcoming] for full descriptions and justification).

Value-added innovations offer something better than what is already in place. Similar to Rogers' (2003) notion of the relative advantage, the potential benefits of value-added innovations visibly outweigh the investments required to yield them. *Clear* innovations enable participants to easily envision their involvement. Innovations may be clear through high levels of explicitness (cf. Fullan & Pomfret, 1977) through a priori specifications of procedures (cf. Doyle and Ponder, 1978) and/or interactive mechanisms whereby developers and users co-define (elements of) the innovation. *Compatible* innovations are congruent with existing values, cultures, practices and beliefs (cf. Doyle & Ponder, 1978; Fullan & Pomfret, 1977; Rogers, 2003; Zhao, Pugh, Sheldon & Byers, 2002). They are still innovative, but the innovations and/or their underlying assumptions do not violate or reject fundamental concerns and principles of those involved. Compatible innovations are also aligned with non-changeable aspects of the educational system, such as assessment frameworks or policies (cf. McKenney, Nieveen & van den Akker, 2006). Finally, *tolerant* innovations are those that "degrade gracefully" (cf. Walker, 2006) as opposed to yielding "lethal mutations" (cf. Brown & Campione, 1996) during the natural variation in enactment that inevitably comes along with differing contexts, resources, expertise, acceptance levels and so on. Tolerance refers to how precisely core components must be enacted for the innovation to be true to its goals, and how well an innovation withstands local adaptations.

If designing for the zone of proximal implementation includes creating innovations that are value-added, clear, compatible and tolerant, then it makes sense to consider how these characteristics can be embodied in designed innovations. Table 1 offers considerations of what would need to be studied in order to derive design inputs related to each of these characteristics. For each characteristic, the focus of inquiry is defined (with slight variations depending on the stage of TEL innovation development). In addition, methodological recommendations are given for studying each characteristic (grey cells).

Table 1. Methodological considerations for researching TEL innovations at the zone of proximal implementation

	Before design (needs/context analysis)	**During design** (prototyping and formative evaluation)	**After design** (summative evaluation)
Value-added (better than status quo)	Learning practices, problems, outcomes *in the baseline situation*	Learning practices, problems, outcomes *during use*	Learning practices, problems, outcomes *with all implementation scaffolds removed*
	Observation, learner work/assessments, document analysis, brief questionnaires (e.g. learning environment rating scales) to study enacted curriculum; focus groups and interviews to get teacher perceptions		
Clear (participants can envision their involvement)	Mindsets, habits and conventions within the classroom/school *in the baseline situation*	Mindsets, habits and conventions within the classroom/school *during use*	Mindsets, habits and conventions within the classroom/school *that are sustained or changed after the innovation*
	Interviews, observations, and logbooks to track how clearly professionals understand their role and how actively they engage in it		
Compatible (compatible with values, beliefs, surrounding educational context/system)	Values, cultures, beliefs, priorities, and contextual /system factors *in the baseline situation*	Values, cultures, beliefs, priorities, and contextual /system factors *that help or hinder implementation*	Values, cultures, beliefs, priorities, and contextual /system factors *that are sustained or changed after the innovation*
	Observation, interviews, document analysis to understand and track how alignment between the innovation and other determinants of implementation		
Tolerant (withstands the natural variation of actual use)	Actual behaviors of teachers and learners and reasons for them *in the baseline situation*	Actual behaviors of teachers and learners and reasons for them *during use*	Actual behaviors of teachers and learners and reasons for them *with all implementation scaffolds removed*
	Observation, interviews and document analysis to understand what teachers and learners actually do and why		

Conclusion

The importance of understanding where teachers and schools are, and framing innovations to be within a reachable distance from that, has been described in TEL literature previously (e.g. Bielaczyc, 2006; Blumenfeld, 2000; McKenney & Voogt, in press). This paper emphasizes that more work is needed to help TEL designers and researchers do so. Research is needed to develop and refine understanding that can feed design (e.g. design principles, patterns and heuristics); and examples are needed to demonstrate how these ideas can be embodied in actual TEL scenarios. Moreover, choices are needed to focus research and development efforts on exploring new possibilities that address urgent – and not merely quasi – needs in existing classrooms.

Conducting research at the zone of proximal implementation inherently involves collaboration with practitioners (not only taking concerns seriously, but also drawing on their expertise), and appreciation of the reach and limitations of their role in determining what actually happens in classrooms. For some researchers, this can require fundamental changes in the researcher-practitioner relationship (e.g. Confrey, 2000). It may also mean learning to accept what Barab, Dodge, Thomas, Jackson and Tuzin (2007, p. 297) refer to as 'a life of compromises':

> "… several interrelated tensions also emerged as problematic for our efforts yet illuminative of critical design work more generally, including (a) tensions among preexisting biases and supporting local needs, (b) tensions between empowering teachers and empowering children, and (c) tensions between local design work and more general products and theories. Further, related to the three of these is a more global tension recurrent in the prior discussion of the process of critical design work, namely, the critical design researcher's responsibility to understand the local concerns and use an appreciation of the literature to characterize the local context in a way that considers local problems but with broader significance."

While it may take time for researchers to adjust to different relationships, or to make peace with the tensions that come along with pursuing the dual aims of generating theoretical understanding while developing TEL scenarios for use in specific practical settings, the benefits of such pathways seem to warrant the effort. If we truly care about the relevance and practical applicability of research, then, alongside investments in research and development of what might be technically possible, we must invest in understanding and designing for what is realistically feasible: in the zone of proximal implementation.

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