From the Hill to the Swamp: Combining Research and Practice

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While the value of research to educational practice is commonly acknowledged, bringing research-based knowledge into practice in classrooms and broader educational systems has many challenges. Simply communicating the results of research does not appear to result in its use in classrooms. Coupled with this, the integrity of classical research methods has often been achieved by separating research from the natural environment of the classroom. New research methods are shifting the unit of analysis from individual variables to classrooms as micro-systems. Research and teaching are coming closer together, not just in individual classrooms but also across whole educational sectors, particularly in the early years of school.

There is a common sense view that decisions based on research are better than decisions not based on research. However, the question of when is it appropriate to generalise from research is not always applied to the belief in the efficacy of research-based decision making in education. What are the limits and constraints on using research in educational systems?

The traditional dilemma of research and practice is the question of which should lead. Does one wait for innovative practice to occur so that the changed practice can be researched or should innovation always be based on educational research? As with the analogous question of which came first, the chicken or the egg, it may be preferable that they arrive together.

Hiebert (1999) in addressing the research related to the NCTM standards, outlined limits on the types of questions educational research can reasonably answer. Researchers can collect information to help us understand current practice and sometimes help to prevent us from engaging in fruitless debates. At times misunderstood research contributes to fruitless debates. Perhaps foremost among the examples that spring to mind is the debate that resulted from confusing constructivism, a theory of epistemology, with discovery learning, a view of pedagogy (Cobb, 1988). Sometimes this confusion led teachers to believe that they should never tell students anything (Lobato, Clarke & Ellis, 2005). No doubt this confusing of a theory of epistemology with a theory of pedagogy can be attributed to the limitations of "conduit models" of communicating research. The problem may not be in the research but how the research is communicated and translated.

The common mode of communicating research findings, namely the closing section of a paper often described under a heading similar to "implications for teaching", rarely works. Despite the best efforts of authors and editors, the stated implications for teaching of the research rarely make it to the consciousness of most teachers yet alone into practice. The inclusion of research summaries in professional journals can broaden the readership of research. Research summaries (Kilpatrick, Martin & Schifter, 2003; Sowder & Schappelle, 2002) can improve the communication by organising research around identified themes. While these improvements in communicating the findings of research are commendable, they do not of themselves result in wide adoption of research findings.

In addition to the problem of communicating the findings of research, the usefulness of research for practice is impacted on by the scientific method underpinning educational research design. Almost twenty years ago, Donald Schön

(1987) used an analogy to describe the challenge of linking educational research design to practice. He described a high, hard hill of research-based knowledge overlooking the soft, slimy swamp of real-life problems. Up on the hill, simpler problems respond to the techniques of basic science whereas down in the swampy lowland, messy, confusing problems defy technical solution. Should the researcher "remain on the high ground where he can solve relatively unimportant problems according to prevailing standards of rigor, or shall he descend to the swamp of important problems and nonrigorous inquiry?" (Schön, 1987, p3) As Schön noted, the irony of the situation is that the problems of the high ground tend to be relatively unimportant to individuals or society at large, however great their technical interest may be, while in the swamp lie the problems of greatest human concern.

Ann Brown (1992) described the same challenge of transferring classically controlled laboratory research to the "blooming, buzzing confusion of classrooms" in outlining a rationale for the development of design experiments in education. Brown describes design experiments in education as engineering innovative educational environments and simultaneously conducting experimental studies of those innovations. Perhaps the most significant shift for a design experiment is that the unit of analysis shifts to the classroom as a system. Just as we cannot make changes in one key component of a classroom system without creating perturbations in others, so too it is difficult to study any one aspect in isolation from the whole operating system.

Hiebert (1999) reminds us that most educational outcomes are influenced by more factors than we can identify, let alone control. The development of robust in situ research methods such as design experiments where the focus of study is classroom learning provides promise that the hill of research-based knowledge can move.

Another recent element of mathematics education research that offers practical aid to implementing research on a broad scale is Simon's (1995) notion of a hypothetical learning trajectory. The hypothetical learning trajectory is made up of three components: the learning goal that defines the direction, the learning activities, and the hypothetical learning process. The hypothetical learning process is a prediction of how the students' thinking will evolve in the context of the learning activities. The hypothetical learning trajectory used in a design experiment on teaching linear measure is described in detail in the JRME Monograph No.12 (Stephan, Bowers, Cobb & Gravemeijer, 2003).

The use of hypothetical learning trajectories in describing ways of differentiating pedagogy (Sullivan, Mousley & Zevenbergen, 2004) holds significant promise in using educational research to facilitate change on a wide basis. The reason that I believe this area of research is of use to educational systems is because I believe that it attempts to address the issue of the crossover between microgenetic and macrogenetic research designs. "Microgenetic" studies are small-scale studies of the development of a concept, frequently looking at change in the individual (Siegler & Crowley, 1991). The application of hypothetical learning trajectories to differentiated pedagogy looks at the issue of learning in the individual and how this relates to collective learning trajectories.

The key issue for systemic adoption of research is user-friendliness. By this I do not mean watering down the findings of research. Rather, user-friendliness from the point of view of an educational system means that the investment made by teachers, schools and those involved in supporting schools and teachers, must be justified through the return in students' learning. Learning frameworks that synthesise multiple research studies are often of greater use to educational systems than traditional modes of synthesising research, such as meta-analysis. Even the conclusion of Hembree and

Dessart’s (1986) classic meta-analysis of 79 research reports on calculator use provided challenges for implementation. Hembree and Dessart concluded that for grades *other than fourth*, calculators positively affect mathematics achievement. Clearly this was a replicable piece of meta-analysis meeting prevailing standards of research. However, what would this mean for educational practice? Should we prohibit the use of calculators in fourth grade? Was the exception of fourth grade a “real issue” or an artefact of the research designs? Meta-analysis is excellent for summarizing research findings but is limited by the quality of the original studies.

Learning frameworks that embody psychological models or similar strong explanatory frameworks can assist teachers to answer questions central to their practice. Simple research designs are generally directed to answering a single question. Learning frameworks provide opportunities to integrate multiple research studies and open up pathways to higher-level use of research. They can assist teachers to develop answers to key questions underpinning the design of learning experiences that meet the needs of students. These questions are frequently stated as, (a) “Where are they now?”, (b) “What do they need to learn next?”, (c) “How can I help them to get there?”, and (d) “How will I know when they get there?”. Learning frameworks can provide a clear sense of direction for instruction and learning.

In addition to the effective organization of research-based knowledge on mathematics learning, research into teacher change needs to be used to scale-up innovative practice (Clarke, 1994; Guskey & Huberman, 1995; Sykes & Darling-Hammond, 1999). The transference of research methods, such as action research (Atweh, Kemmis & Weeks, 1998; O'Hanlon, 1996) to professional learning models in action learning (McGill & Beaty, 1992) echo the movement of research from “on the hill” to “in the swamp”. Most forms of action research are participative, as change is usually easier to achieve if those affected by the change are involved. Action research and action learning can be viewed as emergent processes that take shape as understanding increases. Similarly, the use of Lesson Study (White & Southwell, 2003) as a mode of professional development, makes use of school-based participative learning that could be applied across a school system.

Large scale, system wide adoption of research draws from at least two domains, mathematics education research and professional learning research (Bobis et al., 2005). Education systems can more readily make high-level use of mathematics education research when it brings together the principles of design for effective learning in mathematics with those of professional learning. Davis (1996) has suggested that the themes of designing learning experiences that meet the needs of students, and understanding more deeply what is involved in the way humans think about mathematics, are intimately related. I would add to this connection teachers as learners and systems learning. It is clear that what teachers do is directed in no small measure by what they think. Teachers’ instructional decisions are often based on what they know and believe about students’ learning. Weaving together research themes of developing teacher knowledge and children’s knowledge through learning frameworks can build on the principles and tradition of seminal projects such as Cognitively Guided Instruction (Fennema et al., 1996).

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