Preface to Part V

The Increasing Importance of Mathematics Education as a Design Science

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Much has been written about the 2008 National Mathematics Advisory Panel Report released in the United States. Although this report addresses mathematics education in the US, one cannot ignore its ramifications for research and policy development in other nations. Of particular concern is the Panel's adoption of a narrow and strict definition of scientific rigour, and the almost exclusive endorsement of quantitative methods at the expense of qualitative research (Kelly 2008):

> More researchers in the field of mathematics education must be prepared, venues for research must be made accessible, and a pipeline of research must be funded that extends from the basic science of learning, to the rigorous development of materials and interventions to help improve learning, to field studies in classrooms. The most important criterion for this research is scientific rigor, ensuring trustworthy knowledge in areas of national need. (NMAP 2008, p. 65)

Such has been the concern for the Report's impact on the future of mathematics education that a special issue of *Educational Researcher* (2008) was devoted to the topic. The authors of each of the articles highlight the major shortcomings of the Panel Report and note that research methods must reflect the nature of teaching and learning as it occurs in complex social settings. As Boaler (2008) pointed out, "Far from providing a scientific review that would be helpful to policy makers and teachers, the ideological nature of the task group's report means it is likely to perpetuate myths and fears about non-traditional teaching as well as provide barriers to any advancement of understanding about the complexities of teachers' work… It is now incumbent on researchers in mathematics education to correct the serious errors that have been made." (pp. 589–590)

In advancing mathematics education as a design science, Lesh and Sriraman's chapter remains timely and helps rectify some of the misconceptions evident in the Panel Report. As they point out in their chapter, it is only comparatively recently that we have begun to clarify the nature of research methodologies that are distinctive to mathematics education. By viewing mathematics education as a design science,

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researchers draw on several practical and disciplinary perspectives that are needed for solving the complex problems of learning and teaching as they occur in "messy" environments. Randomized controlled trials as part of the "scientific rigour" advocated by the Panel Report are inadequate in addressing such problems. As Lesh and Sriraman indicate, design science is powerful precisely because it addresses the complexity of teaching and learning, with learners who are continually changing and who are influenced by social constraints and affordances. The conceptual systems we need to understand and explain the growth of these learners are also changing. Such growth usually involves a series of iterative design cycles, reflecting those that designers go through in creating powerful constructs and products.

In providing observations about mathematics education as a distinct field of scientific inquiry, Lesh and Sriraman stress the importance of researchers helping practitioners ask better questions by focusing on underlying patterns and structures rather than superficial pieces of information. Furthermore, when developing and assessing innovative curriculum interventions it is not enough to know *that* something works but we need to explain *how* and *why* it works as well as the nature of the interactions that take place among the participants in a learning environment. Design science enables researchers to achieve this, in contrast to the scientific studies advocated by the Panel Report.

In the second half of their chapter, Lesh and Sriraman address how design science allows exploration of complex systems, such as classrooms that are dynamic and continually adapting. As they note, random assignment and quasi-experimental designs tend to be based on various assumptions that are inconsistent with the types of complex and continually adapting systems that are of most relevance to mathematics educators.

In concluding their chapter, Lesh and Sriraman point out that most research in mathematics education appears to be driven by ideologies rather than by theories or models. Sadly, the strong attraction of ideology is becoming more apparent across many spheres, not just education. Such ideologies tend to ignore the core issues of teaching and learning as they occur in the rapidly changing environment of today's learner. Design science enables multiple theory development and refinement that can address and explain these core issues.

References

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