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Guiding Mathematics Instruction using Research-Based Evidence

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It seems to me that mathematics educators have a great advantage over many educators from other disciplines based on their study of statistics and experience with data analysis. As mathematics educators, we are often challenged to take the initiative to a) use these skills to inform others and influence policy and b) focus our analytical skills on the *evaluation* of evidence-based research studies that are being used to guide our own teaching practice and that of our colleagues. The analytical skills I am talking about are those that may help mathematics teachers and policymakers avoid fads, uncover and utilize the hidden strengths of various and respective teaching materials and practices, and make sense of the flurry of research being done in our discipline.

Since the foundation of our skill with the analysis and interpretation of data is established by our training (e.g., mathematics, statistics, assessment, and research methods), we expect to find some common elements present in quantitative research studies before we accept the recommendations as useful. For example, we expect the study to engage an appropriately large and representative sample and randomized selection; and, the data that we use to make inferences must meet the assumptions that correspond to the statistics or parameters of the research design. However, there are some other important factors that we intuitively know should be considered. It is these factors that mathematics educators are most suited to observe and explain in our discussions of research findings with our colleagues.

I was reminded of how the quality of statistically-based research may mislead practitioners and policymakers while reading the May 2009 issue of the NCTM *Journal for Research in Mathematics* [JRME]. In this issue, Hill and Shih (2009) describe several factors that influence the quality of recommendations forthcoming from current reports of statistically-based research in mathematics. Their reviews of 10 years of JRME articles and respective analysis of the 47 reports of statistical research in mathematics education reveals that "there are compelling reasons to improve our research practices through strong design, analysis, and reporting" (Hill & Shih, 2009, 242). Hill and Shih describe several areas of improvement that are needed to make mathematics education research more useful. It is their suggestions that I believe mathematics educators are so capable of understanding and applying.

One of Hill and Shih's (2009) recommendations is to "disentangle treatment, classroom, and instructor effects" (245). For example, in studies that compare treatment and control groups taught by small groups of teachers, the outcome of the comparison may be influenced by preexisting variations in the teacher or classroom. Findings are obscured by interactions between students and students and between students and the teacher. Similarly, researchers need to include well-theorized controls in quasi-experimental research by designing studies that control for as many threats to statistical inferences as feasible to be confident when drawing conclusions. Hill and Shih write:

> Increasing the number of covariates means careful thought at the study planning stage about reasonable threats to the inferences one wishes to draw: Is it possible that students in some schools or classrooms might put forth more effort? Be more mathematically talented or motivated at the outset? Have teachers who are differentially prepared to enact the treatment? These threats must then be instrumented via surveys or other means of data collection, and tested in final models. (p. 247)

The most intuitive of all of the recommendations made by Hill and Shih (2009) are those that require reporting on the reliability and validity of instruments and, the use of properly scaled measures when applying statistical tests. Based on comments that we have heard from students, parents, teachers, and the general public, we know that flaws in tests and survey items are often easily recognized. Measures of reliability, for example, will expose flawed multiple choice questions such as those that have stem-embeded clues to the correct answer. A mathematics test will not appear to be a valid measure of mathematics if it includes lengthy reading passages. And, mixing non-scaled scores (i.e., number correct and percent correct) to make inferences from statistical tests makes no more sense than saying that 4 centimeters and 3 inches equals 7 inches.

Hill and Shih (2009) indicate that there are some important factors that should be applied to the analysis and reporting of mathematics education in order for it to be more useful to practitioners and policymakers. Their review implies that we should avoid over-interpreting the outcome of research that does not address standards for the analysis of statistical data. As mathematics educators, we need to apply our strong analytical skills. We need to be able to read and evaluate research, and encourage our colleagues to do the same, *before* applying research recommendations. In this way, we will be able to reserve our collective energies and resources for the work that is most likely to support student learning.

References

Hill, H. C. & Shih, J. C. (2009). Examining the quality of statistical mathematics education. *Journal for Research in Mathematics Education, 40*(3), 241-250.

For additional exhibits of the 47 articles reviewed by Hill and Shih and the coding techniques used in this study go to NCTM's http://my.nctm.org/eresources/article_summary.asp?URI=JRME2009-05-241a&from=B

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