# Mathematics Education Qualifying Exam
August 2011

The following six questions constitute the Mathematics Education Qualifying Exam for August of 2011. The questions are separated into two sections. You must answer two of the three questions in Section I and all questions in Section II. In Section I, make sure it is clear which questions you are answering. You have four hours to complete this exam. Remember to save your work frequently.
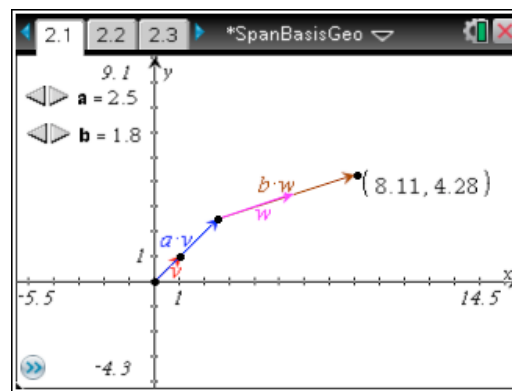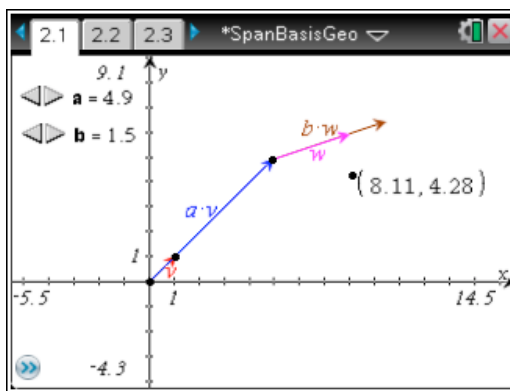
Section I:

1. Kaput, Blanton, & Moreno (2008) proposed a model for the development of symbol systems in mathematics whereby individuals begin with crude representations and then refine those representations through interaction between the world being represented and the world of symbols that are doing the representing (see diagram below). At each iteration of the model, the student begins to see the world that is being represented through the lens of the new symbols that are doing the representing and thus gains new insight into the mathematics itself. From a teacher's viewpoint, describe how Kaput, Blanton, & Moreno's (2008) model can be used for planning instruction for the concept of function and the development of standard function notation and cite research to support your pedagogical decisions. Assume you have access to graphing technology and a computer algebra system.
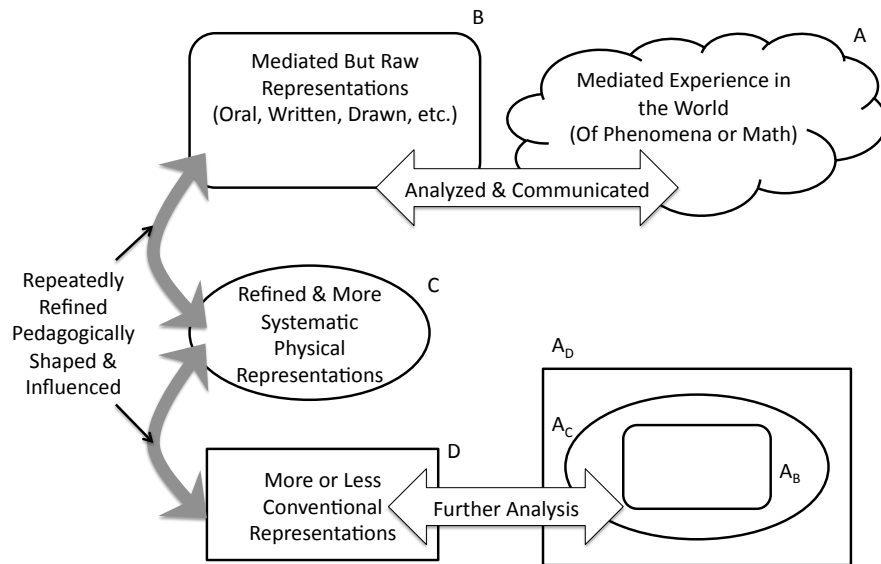
2. Research on the use of data collection devices suggests that the real-time display of graphical and physical events across representations allows the student to link varying views of concepts at different level of abstraction (Lapp & Cyrus, 2000). Technology that allows dynamically linked representations could be considered a "micro-world" extension of the research findings from MBL/CBL technology where the "physical world" is replaced with split-screen images among graphical, numerical, and algebraic representations. Consider a simple electronic document where a parabola can be manipulated on the screen and its factored form is dynamically updated in the window directly below it (see images below). Describe how you would use this document to teach the zero property of multiplication as a technique for equation solving and cite results from the literature to support your pedagogical decisions.
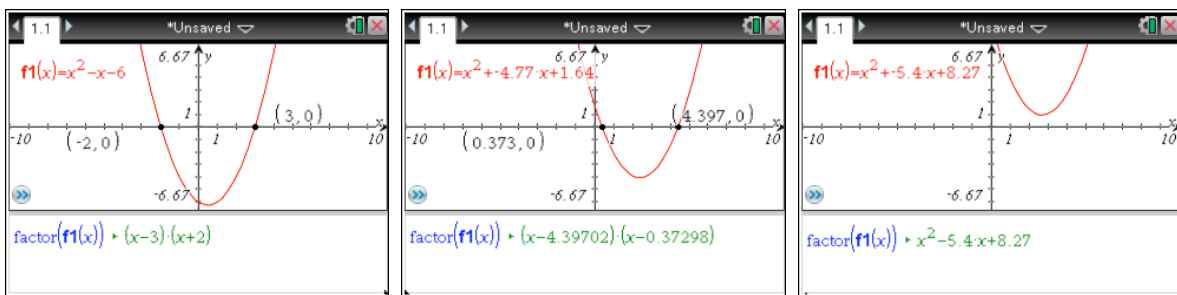
3. In the teaching and learning of linear algebra, students often resort to procedural views of concepts because the traditional thought has been that as students become more proficient at the procedures, they will come to understanding the concepts. Heid (1988) and others have challenged the traditional ordering of skills and concepts within the curriculum by proposing that reordering these so that concepts are developed prior to the skills has greater benefits for the development of both. Consider the following dynamic document where sliders control the scalar values in a linear combination of vectors and the given point in the plane is movable to any location (see images below). Describe how you would use this file to teach the concept of spanning set and how you might modify the file to then teach the concept of basis. Cite any relevant literature from your readings to support your pedagogical decisions.

Section II:
You are to read the study by Hollebrands, Conner, and Smith (2010), then provide your responses to the items below.

1. Finding appropriate variables is one of the most important tasks when designing research. First, examine the study to identify and describe some of the various kinds of variables found in the study: independent, manipulable, observed, explanatory, dependent, intervening, contextual and surrogate. Next, use the significant variable's descriptions to tell what was the focus of this study.

2. Describe, with some detail, the kind of study completed. Show how this study contains: clear research questions, a theory base for the research, well-chosen variables, adequate descriptions of the context, a statement of methods, analysis procedures, appropriate generality in results, and a clear separation of conclusions from conjectures?

3. How does this study contribute to evidence-based pedagogy? Include elements of the study to explain some of the ways the study contributes to knowledge about teaching and learning of Geometry. Describe the value the study would have to a teacher of College Geometry.