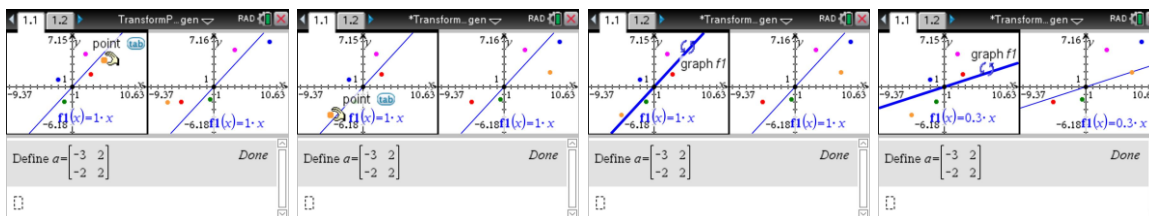


**Mathematics Education Qualifying Exam
August 2018**

Section I:

1. Recall from MTH 761, when discussing the teaching and learning of linear algebra, we used a file titled *TransformPointsEigen.tns*. This file has a split screen (see images below) where, on the left, there are colored points (vectors) that can be manipulated and, on the right, the transformed images of these vectors (in the same color) that are linked to the original vectors by an editable transformation matrix given in the window below. In addition, there is a rotatable line through the origin that students can use to help see when points are colinear. In case you would like to refresh your memory of how the file works, a copy of this file is provided on the TI-Nspire CX CAS calculator given to you to use for this exam.



One of the themes throughout MTH 761 was the use of technology to allow dynamically-linked representations to be used as a tool for developing mathematical concepts. Describe how this file might be utilized for the teaching and learning of eigenvalues and eigenvectors. Be sure to provide appropriate references to the research literature (e.g. theoretical models, empirical studies) for justifying instructional decisions and representational evolution by students. Where possible, referencing specific authors is preferable. In particular, discuss how the approach of *guided reinvention* as described in Larsen (2013) could serve as a local instructional theory for lesson design.

2. As we look at facilitating classroom discourse, we can categorize this discourse into 5 routines as follows:

1. Re-voicing students' contributions
 - Restating student ideas to help clarify
2. Orienting students to each other
 - Facilitating interactions between students and orchestrating discussion
3. Pressing for explanations
 - Interactions with students to encourage elaboration of ideas. The teacher does not allow the student to simply state an answer that is unsupported.
4. Connecting students' ideas
 - Orchestrating discussion that helps students make connections between ideas voiced by different students or the teacher.
5. Making the structure of the discourse visible
 - Helping students become aware of their own thinking process.
 - Helping students become aware of each other's thinking (public)

Consider the attached vignette, *Inverse Functions: The Case of Tim*, from a high school algebra class where the teacher is giving instruction on the concept of inverse functions. Give your responses to the two questions that follow.

- a. The teacher should use these discourse routines to center the focus on the students' thinking and work to establish and support productive mathematical discourse. In what ways did the teacher in the vignette, Tim, succeed or fail to accomplish these goals? Explain your thoughts citing specific instances. Particularly, in looking at the discourse routines listed above, identify where in the vignette the teacher employed them. Be specific and cite instances along with how the student(s) responded.
- b. Consider the video excerpts of the *Border Problem* taught by Cathy Humphreys provided on the flash drive for this exam. Compare and contrast the discourse routines used by Tim from the *Inverse Functions* vignette with those used by Humphreys in the *Border Problem* video case. Discuss the types of questions asked by each teacher and the responses they elicited from the students. In particular, relate these discourse routines to Kaput, Blanton, & Moreno's model for the development of symbolic meaning.

Vignette and video deleted due to copyright restrictions.

Section II:

You must answer both numbered items below. Both items refer to the 2012 paper by Griffith, Adams, Gu, Hart, and Nichols-Whitehead used in MTH 762. (This paper is provided on the USB drive for you.) In your responses, make sure to appropriately include Schoenfeld's ideas about judging models, theories, and studies, as well as additional published ideas by other scholars from your readings.

1. Describe 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. Finally, include your suggestions for a follow-up study, with your rationale.
2. Share your ideas and the ideas of other scholars about what constitutes evidence-based pedagogy. How does this study contribute to evidence-based pedagogy? Include specific elements of the study to explain some of the ways the study contributes to knowledge about teaching and learning. Reference and include ideas about evidence-based pedagogy found in the materials you cited in your final course project.