Instructions:

The use of a cell phone is prohibited during this exam period. Please check at this time that your cell phone is turned off or set to silent mode.

Save this file on your computer, with your initials added to the beginning of the current file name. For example, if your name were Ima Reasoning Fan, then you would save this document as IRF_MathEdQual1_2010.doc(x). After you've completed the exam, delete the questions that you did NOT choose from the document, but keep the original numbering of the questions.

You <u>must</u> respond to either Question 1 or Question 2. In addition, respond to 2 (two) other questions of your choosing from the remaining list. Provide responses to entire questions, not parts of multiple ones.

All responses should be in essay form; aim for clarity and explicitness, as well as thoroughness, concision, and coherence in your writing. Your responses must be original; you may not insert text that you have prepared prior to this exam. Nor may you consult abstracts or articles that you might have on your computer or in paper form.

You may use diagrams in your responses; label each with a title (e.g., "Figure x"), and insert a clear reference to each figure in the appropriate place in your narrative. Turn in any diagrams with your responses.

Your responses may cite literature that is not explicitly mentioned in a question. You may use Endnote to insert references. Good luck and good writing!

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FOR YOUR FIRST ESSAY, ANSWER EITHER QUESTION 1 OR QUESTION 2

Question 1

Imagine that you, as a mathematics education researcher, have been approached by a local high school administrator for advice in the following matter:

> Dear Mathematics Education Expert,
>
> I am the Principal at Mustang High School in the Desert High School District. We are considering a bell schedule change and I was wondering if you could help me locate research with regards to math instruction.
>
> I am trying to find out what the research says is best for students with regards to the length of class time for math instruction. We currently have 100 minute class periods (block schedule) and are considering going back to a traditional schedule where classes meet every day (55 minutes).
>
> I hope you can point me in the right direction.
>
> Thank you,
>
> Mr. Helpem Learn
> Principal
> Mustang High School

Craft a response to Mr. Helpem Learn addressing whether or not certain educational practices can be labeled as “good” versus “bad,” using the results discussed in *The Teaching Gap* (Stigler & Hiebert, 1999) as a touchstone for your argument. Strengthen your response with specific examples from additional sources that demonstrate the types of questions and issues mathematics education researchers have chosen to address.

Question 2

In Thompson’s (1992) discussion of students’ understanding of functions and the undergraduate curriculum, he framed the following challenge:

> I propose that we orient ourselves toward developing *conceptual* curricula – curricula that are mathematically sound, but nevertheless are constructed from the start with an eye to building students’ understandings, and are constructed to assess skill as an expression of understanding. (p. 25)

Interpret this challenge by expanding on what a conceptual curriculum entails and what lies beneath its development. In your response, address the following: a) What does mathematics education research have to say about the importance of incorporating students’ understandings in curricular design?; b) What role do constructs play in achieving this goal?; c) How does research inform us regarding the relationship between assessments of skill and understanding?

FOR YOUR REMAINING ESSAYS, ANSWER TWO OF THE FOLLOWING:

Question 3 (Tasks and constructs)

Below are four examples of tasks given to Ann in the context of the Over & Back teaching experiment (Thompson & Thompson, 1994a; 1996).

Activity	Example
1	Turtle is going over at 20 feet per second, coming back at 30 feet per second. How much time does he take?
2	Give Rabbit a speed that will make him go over and back in 7 seconds.
3	Turtle goes over at some speed and comes back at 70 feet per second. Rabbit goes over and back at 30 feet per second. Give Turtle a speed over so that he and Rabbit tie.
4	Sue paid $9.46 for Yummy candy bars at $0.43 per bar, and she paid $6.08 for Zingy candy bars. Sue bought 38 of these candy bars. What was the price of a Zingy candy bar?

a) How do you see each task contributing to the researchers' goal of investigating students' construction of the concepts of speed and rate?
b) Give another example from one of our readings that illustrates how the selection and construction of an experimental task is instrumental in the emergence of constructs.

Question 4 (Theoretical bases for constructs)

Lobato and Siebert (2002) discuss quantitative reasoning in a reconceived notion of transfer.

a) Characterize this reconceived notion of transfer. Include a description of how this notion differs from the "traditional transfer paradigm."
b) Discuss the implications for different definitions of transfer in terms of research (e.g., the ways in which evidence is gathered, the nature and amount of transfer observed, and the perceived nature of the transfer situation.) What are methodological limitations that accompany this reconceived notion of transfer?

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Question 5 (Identifying and communicating alternative constructs)

a) Describe and contrast an *additive* versus *multiplicative conception of sample* as constructs for describing statistical inference (Saldanha & Thompson, 2002). How does the figure constructed by the authors (Figure 1) capture and communicate the characteristics of these two alternative conceptions of sample?

b) Give at least one reason why the distinction between the additive and multiplicative conceptions of sample is significant.

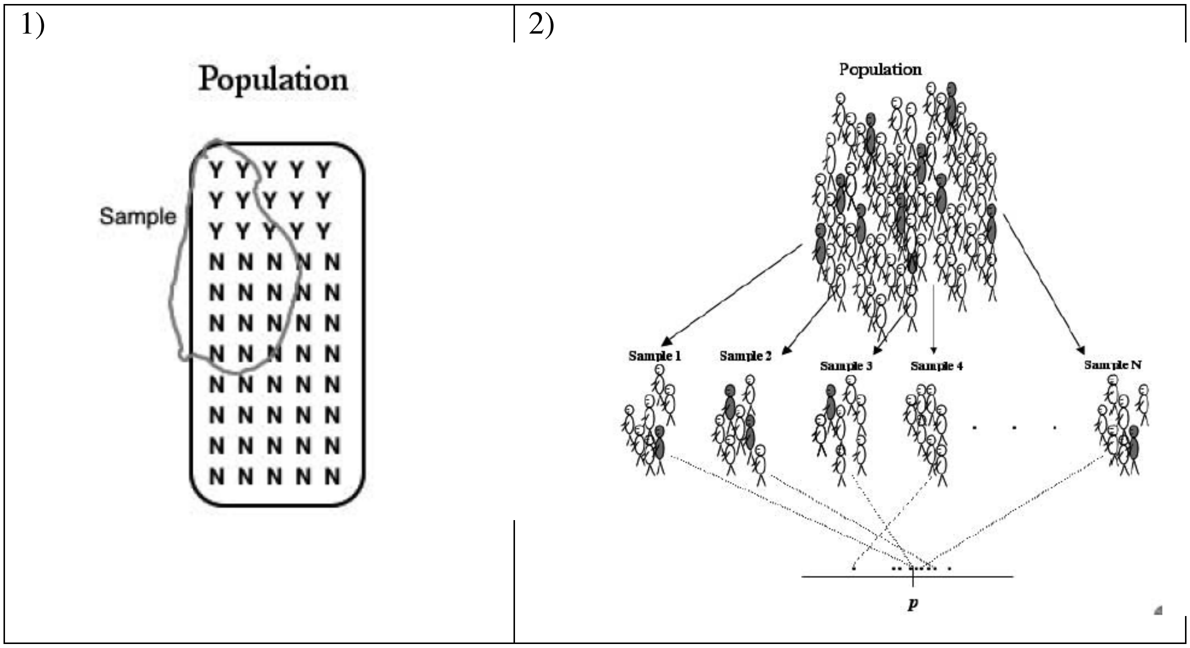

Figure 1. Depictions of two alternative conceptions of sample (reproduced with permission from the authors)

Question 6 (Construct trajectories)

Sfard (1992) identifies three components of concept development, namely *interiorization, condensation, and reification*, which constitute transitions from operational to structural conceptions of mathematical entities.

a) Characterize what Sfard means by each of these three constructs. Include a discussion of why reification, in particular, is necessary but challenging to attain. Your response should address the meaning of operational versus structural conceptions of mathematical entities.
b) On what basis does Sfard argue that “new concepts should not be introduced in structural terms?”