JMB JOURNAL OF MATHEMATICAL BEHAVIOR, **17** (4), 429 – 439 ISSN 0364-0213.

Interviewing in Mathematics Education Research: Choosing the Questions

RINA ZAZKIS
Simon Fraser University, Burnaby, BC, Canada V5A 1S6

ORIT HAZZAN
Technion, Haifa 32000, Israel

With the development of qualitative methodologies, interviewing has become one of the main tools in mathematics education research. As the first step in analyzing interviewing in mathematics education we focus here on the stage of planning, specifically, on designing the interview questions. We attempt to outline several features of interview questions and understand what guides researchers in choosing the interview questions. Our observations and conclusions are based on examining research in mathematics education that uses interviews as a data-collection tool and on interviews with practicing researchers reflecting on their practice.

In the past decade qualitative research methodologies have become not only acceptable but also predominant in mathematics education research. Within those, interviewing students has become a popular way of data-collection. However, while there are courses and books on the art and technique of interviewing, studied by reporters, clinical psychologists and police investigators, many mathematics educators, including the authors of this article, entered the field of interviewing with little or no specific theoretical education or practical training in this domain.

Researchers in mathematics education ask questions, get answers and then engage in attempts to analyze these answers. What kinds of questions are being asked? How do researchers choose these questions? What considerations influence researchers' choices? As reflective practitioners (Schon, 1987), whose "practice" is research in mathematics education, we wish to reflect on the process of interviewing about mathematics. We focus here on the stage of planning the data-collection.

The issue of selecting interview questions has served us as a starting point for the development of an organizing theme for interviewing in mathematics education that we intend to pursue in the future. In the spirit of "Grounded Theory" (Glaser & Strauss, 1967), where the theory emerges from the analysis of the field under examination, we have started by reviewing the existing research in mathematics education which used interviews as a research tool. Moreover, we have interviewed active practicing researchers in mathematics education asking them to reflect upon their practice.

Direct all correspondence to: Rina Zazkis, Simon Fraser University, Burnaby, BC, Canada V5A 1S6; E-Mail: zazkis@sfu.ca

1. CLINICAL INTERVIEW AS A RESEARCH TOOL

In the mid-1970s, a few pioneer research reports in mathematics education based their findings on interview data (e.g., Erlwanger, 1973). This started a conversation among researchers on the aims and rationales for a clinical interview (Ginsburg, 1981). Confrey (1980) outlined the benefits for a clinical interview as a "potential to reveal insights in mathematics education", paying attention to individual differences among students and their mathematical conceptions. However, as interviewing became a widely accepted data-collection tool, design and technique of interviewing originated little debate. For example, in the Arithmetic Teacher (recently renamed to "Teaching Children Mathematics") we have found several reports of teachers and teacher educators suggesting individual interviews as an assessment or diagnostic tool, in which the ultimate goal is to inform learning or improve instruction (Schoen, 1979; Liedtke, 1988; Peck, Jencks, & Connell, 1989; Long & Ben-Hur, 1991). However, "despite its emerging popularity, the clinical interview method is not sufficiently understood" (Ginsburg, 1997, p. 28).

Ginsburg (1981) refers to Piaget's theory of intellectual development in identifying three aims for a clinical interview: discovery, identification and competence. That is, accepting Piaget's basic research goal of explication the nature of thought, the task of a researcher in mathematics education is to discover intellectual phenomenon in learner's approaches to problem situations, identify and describe underlying cognitive processes and determine child's competence, that is, his or her capability to perform a certain task. Competence, according to Ginsburg (1981), involves assessment of motivation, understanding the task and strength of belief. Broadening the focus to learners of all ages, we believe that the third component, strength of belief, is of major interest in mathematics education research. Establishing strength of belief helps understand whether a learner's response to a situation was an arbitrary choice or whether it is persistent and robust in his or her approaches.

Ginsburg (1997, p. 28) attempts to convince a reader that a clinical interview offers a "viable alternative, or at least a supplement, to traditional methods" in psychological research and practice. He presents a strong rationale for the need to go beyond "standardized methods," describes history of development and practice of implementing clinical interviews. Further, he provides evaluation of the method using the criteria of replicability, validity and generalization. However, a detailed description of what takes place during the clinical interview and a validation of the research tool do not assist a researcher to address the problem of question design.

It is our impression that the mathematics education community does not need any further convincing. The value of clinical interviews as means to "enter the learners' mind" has been discovered by researchers and the appreciation for this method is growing. Our goal, therefore, is to examine the practice.

2. DEFINING THE FOCUS OF THE STUDY

The research questions we wish to address are: *(1) How is it possible to characterize questions that researchers in mathematics education ask their interviewees? (2) What guides researchers in mathematics education in designing tasks for a clinical interview?*

In this paper we address interviews with students from kindergarten to university. The interviews are clinical, semi-structured, with cognitive orientation on the subject-matter. "Clinical" here pertaining to extensive observation and also "conducted in a clinic", usually an office, outside the natural educational habitat of the interviewees, such as a classroom or a workshop. Clinical interviews are mostly individual. "Semi-structured" means here that the interviews are planned in advance but contingent upon the interviewee's response, allowing unplanned follow up questions, variations on planned questions and clarifying questions. Excluded are the occasional interchanges with students inside or outside the classroom as a part of the teaching setting. "Orientation on the subject-matter" means that we focus on interviews about mathematical content, where the aim is to reveal students' understanding of mathematical concepts. This is a special case of Piaget's basic research goal, namely, to explicate the nature of thought (Ginsburg, 1981). This excludes interviewees' reflections on a learned topic or on a specific teaching approach and the interviewees' feelings about or attitudes toward mathematics.

3. PROPERTIES OF INTERVIEW QUESTIONS

Reviewing research in mathematics education that used clinical interviews as a data-collection tool, as well as reflecting on our own past research, we were able to identify several (not necessarily disjoint or exhaustive) types of questions. In what follows we describe these types of questions and consider their role in learning about students' thinking.

3.1. Performance Questions

Many of the questions posed by researchers to interviewees can be identified as "performance" questions. Those are usually more-or-less standard questions, that frequently appear in mathematics lessons and in school textbooks. Here are some examples.

1. "How would you write 2/10 as a decimal or decimal fraction?" (Erlwanger, 1973, p. 8). "What about 0.7×0.5?" (Erlwanger, 1973, p. 10).
2. "Pat had 8 rocks. Then, he collected some more rocks. Now, he has 14 rocks. How many rocks did Pat collect?" (Carey, 1991, p. 270).
3. "If two liters of juice cost ten dollars, how much will one liter cost?" (Saenz-Ludlow, 1995, p. 108).

These questions are among numerous examples of "performance" questions. Usually these questions are posed to students in order to reveal their familiarity and understanding of a specific topic learnt at school. However, what presents the main interest to researchers is not *what* students are doing, but *how* they are doing it and *why*. Performance questions posed in an interview are often followed by the interviewer's request to explain how the answer was found, why an action or procedure was chosen and how a decision was reached. In short, researchers posing performance questions are usually interested in students' strategies, approaches and conceptions, rather than their performance.

3.2. Unexpected "Why" Questions

"Why" questions in interviewing about mathematics are rather frequent, being asked mostly in order to explain or clarify responses of interviewees. In the type of questions identified here, "why" is being asked in *unexpected* places, about facts or procedures that students got used to without considering the reasons for them. For example, questions such as "why the snow is white?" or "why we cross the street on the green light?" invite to consider information that has been taken for granted. In relation to mathematics education research, here are some examples of unexpected "why" questions.

1. "Why do you think height is distributed normally?" (Wilensky, 1997, p. 185).
2. "You told me how [to do the long division] and now I'm going to ask you why" (Simon, 1993, p. 244).
3. "Why is 4 divided by 0 undefined?" (Even & Tirosh, 1995, p. 9).

In the above examples it is clear that participants were familiar with facts (that is, height is distributed normally, division by zero is undefined) or a procedure (that is, long division), but have never been puzzled by the "why" question. An important attribute of these questions is the novelty they present. Students' responses allow the researcher to learn about students' thinking and understanding beyond the successfully applied algorithms or memorized rules.

3.3. "Twist" Questions

This kind of questions presents a variation on a familiar situation. Here are some examples.

1. "Could you add 2.34 and 4.32 in base 5?" (Zazkis & Khoury, 1994, p. 200).
2. "Can you tell, just by looking, if each pair of shapes below has the same area? Why?" (Baturo & Nason, 1996, p. 265).
3. "How could you find the remainder of 598,473,947 divided by 98,762 by using a calculator?" (Simon, 1993, p. 240).

The situations themselves (i.e., adding decimal fractions, comparing areas or performing division with remainder) appear familiar and without a prior knowledge about students' experiences can be confused with "performance" questions. However, each question above presents a novelty when introducing either a component (base five), a constraint (just by looking) or a tool (calculator) that was not previously utilized in familiar similar situations. The introduction of this component and students' reaction to it provides insight about students' understanding of a more standard situation. From students' approach to (1) we learn whether the addition with decimals is performed automatically or whether there is an understanding of underlying place value concepts. From students' approach to (2) we learn whether there is a conceptual understanding of area or procedural "plugging into formula" performance. From students' approach to (3) we learn about their mental connections between whole number division and division of rational numbers. Such connections, conceptions or ideas may not be apparent if the questions are presented in a standard context without a "twist."

3.4. Construction Tasks

In these tasks, students are asked to build mathematical objects which satisfy certain properties. Here are some examples.

1. "Define a function $f(x)$ by letting $f(x)$ be the distance from a certain train to the station at time x, where x is measured in hours after 12:00 noon on March 1, 1989. At exactly 2:00 p.m. on that day, the train arrives and comes to complete stop at the station. Discuss the limit of $f(x)$ as $x \to 2$." (Williams, 1991, p. 224).
2. "Put price stickers on pictures of nine bags of potato chips, so the 'typical or usual or average' price of the chips would be $1.38." (Mokros & Russel, 1995, p. 23).
3. "What would you say would be a good situation or story for 1 3/4 ÷ 1/2 — something real for which 1 3/4 ÷ 1/2 is the appropriate mathematical formulation." (Ball, 1990, p. 134).

In the first task, a function is to be constructed. The specified constraints are that the function is continuous and that its value at 14:00 is 0. In the second task, a data set has to be constructed. The specified constraint is that the average of the numbers in the set is given. In the third task a story or a situation has to be constructed. The specified constraint is that the story has to be solved by a given number sentence. In a way, these tasks also introduce a certain kind of "twist" or variation. In these tasks the traditional roles of what is "given" and what is to be "found" are reversed. Students are trained in school to find the limit of a given function, the average of a given set of numbers or to write a number sentence for a given problem situation. Such "inversion" usually presents a greater challenge for students than a standard situation. Mokros and Russel (1995, p. 23) described this challenge with words of an eighth-grader participating in their study: "I know how to get an average, but I don't know how to get the numbers to go into an average, from an average."

3.5. "Give an Example" Tasks

An explicit example of a mathematical object or a mathematical property can be requested in an interview. "Give an example" task often presents an alternative wording for a construction task. Below are several tasks of this kind.

1. "Give an example of a six-digit number divisible by 9." (Hazzan & Zazkis, 1997, p. 299).
2. In Breidenbach, Dubinsky, Hawks, & Nichols (1992), students were asked to give examples of functions, and in some cases they were specifically asked to give examples of different kinds of functions.
3. "Can you give me an example where I would think they're [here: fractions] different but the answers were really the same?" (Erlwanger, 1973, p. 14). This question was

posed following the interviewee's claim, that his correct solutions did not match the "answers" in the teacher's answer key.

A request for examples can be open-ended, as in (2), or constrained, as in (1). It also appears as an interviewer's way to help a student make his point, as in (3). Generating examples is not a frequently practiced activity in a traditional mathematics classroom. However, student-generated examples may provide an insight about students' understanding of a situation.

3.6. Reflection Questions

In reflection questions, rather than solving a mathematical problem, interviewees are asked to reflect on a solution presented by an imaginary third person. This third person can be the interviewee's classmate or the interviewee's prospective student. Therefore, reflection is not a feature of a question itself, but rather of the way it is presented. Here are some examples of reflection questions.

1. "*9 boxes of candy. 52 pieces in each box. About how many pieces in all?* This is how Sammy worked this problem. He said: 'Nine is just about ten and 52 is about 50. Ten times fifty is 500. So there are about 500 pieces of candy.' Do you think it was OK for Sammy to use these numbers?" (Sowder & Wheeler, 1989, p. 134).
2. "A student wrote on a test: 'Z_3 is a subgroup of Z_6.' Is it correct, partially correct or incorrect? Please explain your answer." (Hazzan & Leron, 1996, p. 25).
3. "The teachers were asked to assume that one of their students suggested that $(-8)^{1/3} = -2$ because ... [...], while another student argued that $(-8)^{1/3} = 2$, because ... [...]" (Even & Tirosh, 1995, p. 8). The teachers were asked to judge the arguments of these imaginary students.

Reflection questions have several benefits. They help the interviewee to distance himself/herself from the personal performance by responding to someone else's ideas. By presenting a student's solution, these questions shift the focus to the reasons for the solution, rather than to the solution itself. In (2) above, for example, the interviewers had met the specific wrong answer in a written questionnaire. In the interviews, the researchers found out that the reason for that answer was quite different from what they had originally assumed.

4. WHAT GUIDES RESEARCHERS' INTERVIEW DESIGN

In this section, we attempt to describe what guides researchers' choices of interview questions. There are two sources for our discussion: (a) published research reports and (b) interviews with practicing researchers.

There is very little explanation in the mathematics education research reports of researchers' choice of interview questions. Many researchers describe their interview tasks or questions and say that those were designed to assess students' understanding of a given topic or of a particular aspect of a given topic. Many researchers emphasize the probing, the clarification questions and contingency of the method when describing their approach. However, most leave the reader wondering how the specific tasks were designed and how the interview questions were chosen.

Twelve researchers kindly agreed to discuss with us their guidelines or criteria in choosing interview questions. For obvious reasons we cannot reveal the names of these individuals. The only information we can share is that they all are well-known in the community of mathematics education research, they come from four different countries and they represent a wide variety of research interests within the field.

The specific question presented to the researchers was: “How do you choose questions for a clinical interview in your research?” It was followed by the clarification question: “Suppose you’re investigating students’ understanding of a mathematical topic X using interviews. What would influence your choice of questions?” All our interviewees have admitted that their criteria for the choice of the interview questions were implicit and hard to elicit. Some admitted that they have given no serious consideration to this matter before we asked them to. All the researchers emphasized the contingent method of questioning, clarification using “why” and “how” questions, and a possible change in a question or a wording of a question from one interviewee to another, influenced by previous experience. Some claimed that their choices were entirely dependent on the purpose, contents and general context of the interview, and questioned the possibility of any pre-determined criteria.

In analyzing researchers’ responses to our questions together with research reports that do explain rationale for the design of interview tasks, several interrelated themes have emerged: theoretical analysis, subject-matter analysis, researcher’s practice and researcher’s personal mathematical understanding.

4.1. Theoretical Analysis Based Design

There are researchers who are guided by a learning theory. Their interview questions are designed to correspond to a theory and students’ responses serve as identifiers of different aspects or stages presented by a theory.

For example, Baturo and Nason (1996), in their investigation of student teachers’ subject-matter knowledge within the domain of area measurement, generated “substantive knowledge components” and organized these components using a modification of the theory of understanding of Leinhardt (1988). Three knowledge types — concrete, computational and principled conceptual — were incorporated by these researchers. The interview tasks were chosen to assess students’ substantive knowledge in terms of the three knowledge types and to reveal a degree of connectedness between these types of knowledge. Furthermore, Baturo and Nason (1996, p. 243) state that, “production of the tasks and their accompanying scripts [that is, possible interview questions] was assisted by our a priori epistemological analysis of the notions of area and area measurement.”

4.2. Subject-matter Analysis Based Design

Several researchers use an analysis of the subject-matter as a guidance for the questions design. For example, Behr, Khoury, Harel, Post, and Lesh (1997) investigated elementary school teachers' strategies on rational-number-as-operator tasks. They identified two operator subconstructs, namely, Duplicator/Partition-reducer and Stretcher/Shrinker, corresponding to partitive number exchange or quatitive size-exchange strategies, respectively. Their "Bundles and Sticks" interview task consisted of finding three-fourth of a pile of eight bundles of four counting sticks. The numbers were carefully chosen to allow for either strategy to be implemented, so the researchers could learn about students' preferred approaches.

The idea of a careful choice of numbers is mentioned also by Zazkis and Campbell (1996, p. 543), who studied students' understanding of elementary concepts of number theory. One of the questions presented to the participants in this research was "Is 391 divisible by 23?" The authors explain that the numbers were chosen "carefully to eliminate any obvious applications of divisibility properties for specific numbers such as 2, 3, 5, and so forth."

Another example of the design guided by the subject-matter analysis can be found in a report by Even and Tirosh (1995). These researchers investigated subject-matter knowledge of teachers in the domain of undefined mathematical operations. Their subject-matter analysis identified the key requirements for the definition of a mathematical operation: it should be non-contradictory, not-circular and well-defined (as any definition), and it should fulfill the requirements for functions, that is, univalence and being defined for every element in the domain. Following this analysis, examples of operations were designed that did not fulfill at least one of these requirements. These examples included the consideration of $4/0$, $0/0$, 0^0, and $(-8)^{1/3}$. In the interviews, the teachers were asked to describe their in-class reactions to a list of suggested definitions, which were presented as if they were made by students. (This approach has been identified earlier as "reflection questions.")

4.3. Practice Rooted Design

There are researchers who are guided by their practice and the practice of their colleagues. "Practice" here refers to both teaching and research. Having faced students' difficulty in a learning situation, questions are designed to isolate and to determine the source of an observed difficulty. In a way, the researcher's hypothesis is formulated as a result of a learning episode, that is, the "discovery" stage of the interview takes place before the interview. The interviewer becomes concerned with verification, search for underlying structure and the degree of a student's robustness or strength of belief.

Prior research is another important source of questions. Based on previous research experience, researchers decide how questions or tasks can be modified or extended in order to achieve a further understanding of students' mathematical behavior.

4.4. Personal Understanding Rooted Design

A majority of the researchers that we have interviewed explained that they were guided by their own understanding of the concepts involved which combined theory and practice. They were guided by personal constructs of schemas with respect to a given mathematical concept and its relation to other mathematical concepts. These personal constructs are a combination of cognitive or phenomenological analysis of the content domain. They include a researcher's view of the most important features, properties or components of the topic and its connection with related topics.

Asiala et al. (1996, p. 7) integrate most of the above mentioned issues, in claiming that their "analysis is initially made by applying a general theory of learning and is greatly influenced by the researchers' own understanding of the concept and previous experience in learning and teaching it."

4.5. Additional Considerations

A technique presented by several researchers involved students' reflection on their prior work. That is, a written instrument has been administered or a problem situation has been videotaped prior to the clinical interview. In the interview a student was asked to respond to chosen issues in his or her prior work.

Several researchers have mentioned affective issues that influence their choices, such as avoiding intimidation of students and keeping a student invigorated, regardless of the level of understanding s/he is demonstrating. In this case, researchers attempted to choose a task that can be solved using a variety of different approaches. It was the student's choice of approach, rather than the student's "success," that provided information about his or her level of understanding.

5. CONCLUSION

One of the interviewed researchers, Dr. B., has pointed out that s/he (gender concealed) did not believe in pre-planned interview as the best or even adequate way of helping researchers understand mathematical understanding of students. S/he believed in integrating teaching space and research space, where there was no room for pre-selected questions. Acknowledging the complexity of human cognition, Dr. B. saw any deliberate effort to excavate what is going on in people's head as unsatisfactory.

In the beginning of this article, we mentioned Ginsburg's call to psychologists to move beyond "standardized instruments." We could see in Dr. B's reaction a call to the mathematics education community to move beyond clinical interviewing. It is not our intention here to defend the clinical interview method. However, as the method provides researchers with valuable insights about students' learning and understanding of mathematics, the time has not come yet to dismiss it. It was our purpose to understand better its implementation.

Unfortunately, a technology that makes it possible to observe a learner's mind has not been invented yet. Our only means to speculate about students' thinking or understanding is by analyzing their words and actions. A clinical interview provides an opportunity to gather these words and actions.

In defining the scope of this paper, we limited the research to subject-matter-oriented interviews and to planned initial questions. In the future, these constraints can be removed and the study can be extended in at least three directions:

a. Attending to social and cultural aspects of mathematics education,
b. Going beyond initial planned questions and analyzing planned or unplanned follow up questions and different interview techniques, and

c. Exploring the extent to which the general characteristics of interviewing in psychology and educational research can be applied to the mathematics education research and how they should be elaborated or modified.

Designing (good) questions is only one step in "art and science" of clinical interviewing. "Asking questions and getting answers is a much harder task than it may seem at first" (Fontana & Frey, 1994, p. 361). We concur.

REFERENCES

Asiala, Mark, Brown, Annel, DeVries, David J., Dubinsky, Ed, Mathews, David, & Thomas, Karen. (1996). A framework for research and curriculum development in undergraduate mathematics education. *Research in Collegiate Mathematics Education, 2*, 1 – 32.

Ball, Deborah. (1990). Prospective elementary and secondary teachers' understanding of division. *Journal for Research in Mathematics Education, 21*(2), 132 – 144.

Baturo, Annette, & Nason, Rod. (1996). Student teachers' subject matter knowledge within the domain of area measurement. *Educational Studies in Mathematics, 31*, 235 – 268.

Behr, Merlyn, Khoury, Helen, Harel, Guershon, Post, Tom, & Lesh, Richard. (1997). Conceptual units analysis of preservice elementary school teachers' strategies on a rational-number-as-operator tasks. *Journal for Research in Mathematics Education, 28*(1), 48 – 69.

Breidenbach, Danny, Dubinsky, Ed, Hawks, Julie, & Nichols, Devilyna. (1992). Development of the process concept of function. *Educational Studies in Mathematics, 23*, 247 – 285.

Carey, Deborah A. (1991). Number sentence: Linking addition and subtraction word problems and symbols. *Journal for Research in Mathematics Education, 22*(4), 266 – 280.

Confrey, Jere. (1980). Clinical interviewing: Its potential to reveal insights in mathematics education. *Proceedings of the 4th International Conference for PME* (pp. 400 – 408). Berkeley, CA: University of California Press.

Erlwanger, Stanley H. (1973). Benny's conception of rules and answers in IPI mathematics. *The Journal of Children's Mathematical Behavior, 1*, 7 – 26.

Even, Ruhama, & Tirosh, Dina. (1995). Subject matter knowledge and knowledge about students as sources of teacher presentations of the subject-matter. *Educational Studies in Mathematics, 29*, 1 – 20.

Fontana, Andrea, & Frey, James H. (1994). Interviewing: The art of science. In N.K. Denzin & Y.S. Lincoln. (Eds.), *Handbook of qualitative research*. London: SAGE Publications.

Ginsburg, Herbert P. (1981). The clinical interview in psychological research on mathematical thinking: Aims, rationales, techniques. *For the Learning of Mathematics, 1*(3), 4 –11.

Ginsburg, Herbert P. (1997). *Entering the child's mind: The clinical interview in psychological research and practice*. Cambridge, UK: Cambridge University Press.

Glaser, Barney G., & Strauss, Anselm L. (1967). *The discovery of grounded theory: Strategies for qualitative research*. Chicago: Aldine.

Hazzan, Orit, & Leron, Uri. (1996). Students' use and misuse of mathematical theorems: The case of Lagrange's theorem. *For the Learning of Mathematics, 16*, 23 – 26.

Hazzan, Orit, & Zazkis, Rina. (1997). Constructing knowledge by constructing examples for mathematical concepts. In *Proceedings of the 21st International Conference for Psychology of Mathematics Education,* Vol. 4 (pp. 299 – 306). Lahti, Finland: University of Helsinki Press.

Leinhardt, Gaea. (1988). Getting to know: Tracing students' mathematical knowledge from intuition to competence. *Educational Psychologist, 23*(2), 119 –144.

Liedtke, Werner. (1988). Diagnosis in mathematics: The advantages of an interview. *Arithmetic Teacher, 36*(3), 26 – 29.

Long, Madeleine J., & Ben-Hur, Meir. (1991). Informing learning through the clinical interview. *Arithmetic Teacher, 38*(6), 44–46.
Mokros, Jan, & Russel, Susan Jo. (1995). Children's concepts of average and representativeness. *Journal for Research in Mathematics Education, 26*(1), 20–39.
Peck, Donald, Jencks, Stanley M., & Connell, Michael L. (1989). Improving instruction through brief interviews. *Arithmetic Teacher, 37*(3), 15–17.
Saenz-Ludlow, Adalira. (1995). Anna's fraction schemes. *Educational Studies in Mathematics, 28*, 101–132.
Schoen, Harold L. (1979). Using the individual interview to assess mathematics learning. *Arithmetic Teacher, 27*(3), 34–37.
Schon, Donald A. (1987). *Educating the reflective practitioner: Towards a new design for teaching and learning in the profession*. San Francisco: Jossey-Bass.
Simon, Martin A. (1993). Prospective elementary teachers' knowledge of division. *Journal for Research in Mathematics Education, 24*(3), 233–254.
Sowder, Judith T., & Wheeler, Margariete M. (1989). The development of concepts and strategies used in computational estimation. *Journal for Research in Mathematics Education, 20*(2), 130–146.
Wilensky, Uri. (1997). What is normal anyway? Therapy for epistemological anxiety. *Educational Studies in Mathematics, 33*, 171–202.
Williams, Steven R. (1991). Models of limit held by college calculus students. *Journal for Research in Mathematics Education, 22*(3), 219–236.
Zazkis, Rina, & Campbell, Stephen. (1996). Divisibility and multiplicative structure of natural numbers: Preservice teachers' understanding. *Journal for Research in Mathematics Education, 27*(5), 540–563.
Zazkis, Rina, & Khoury, Helen. (1994). To the right of the decimal point: Preservice teachers' concepts of place value and multidigit structures. *Research in Collegiate Mathematics Education, 1*, 195–224.