Int J of Sci and Math Educ (2018) 16:1315–1335
DOI 10.1007/s10763-017-9830-6

Does Training in Alternative Assessment Matter? The Case of Prospective and Practicing Mathematics Teachers' Attitudes Toward Alternative Assessment and Their Beliefs About the Nature of Mathematics

Juhaina Awawdeh Shahbari[1,2,3] · **Fadia Nasser Abu-Alhija**[2,4]

Received: 28 June 2016 / Accepted: 14 June 2017 / Published online: 6 July 2017

Abstract This study explored the training of prospective and practicing mathematics teachers in alternative assessment and its impact on their attitudes toward alternative assessment methods and their beliefs about the nature of mathematics. Data were collected from 51 prospective teachers and 50 practicing teachers who took a course on alternative assessment in mathematics. Findings indicated a significant change in the correlation between the positivist and constructivist dimensions of their beliefs about the nature of mathematics following the course. No significant differences were found between the prospective and practicing teachers' beliefs either before or after the course nor in their attitudes toward alternative assessment after the course. Before the course, however, the two groups differed significantly in their attitudes toward alternative assessment. Findings also revealed significant changes in attitudes toward alternative assessment and beliefs about the nature of mathematics following participation in the course. These changes in attitudes and beliefs were accompanied by a shift in the nature of the assessment tasks written by the participants. Participants who demonstrated more positive attitudes and constructivist beliefs tended to write more conceptual problems and less procedural exercises. Implications for mathematics teacher training and professional development in alternative assessment are discussed.

Electronic supplementary material The online version of this article (doi:10.1007/s10763-017-9830-6) contains supplementary material, which is available to authorized users.

✉ Juhaina Awawdeh Shahbari
juhaina8@gmail.com

[1] Department of Mathematics Education, University of Haifa, Haifa, Israel

[2] The College of Sakhnin, Sakhnin, Israel

[3] Al-Qasemi Academy- Academic College of Education, Baqa al-Gharbiyye, Israel

[4] Tel-Aviv University, Tel-Aviv, Israel

Keywords Alternative assessment · Attitudes toward alternative assessment · Beliefs about mathematics · Practicing teachers · Prospective teachers

Introduction

The standards developed by the National Council of Teachers of Mathematics (NCTM, 2000) emphasized the integral role of assessment in both teaching and learning processes. Five years earlier, it had been determined that traditional tests should not be the only tool for learning assessment, and the need for active assessment by teachers had been stressed (NCTM, 1995). Nonetheless, mathematics teachers still assess their students' learning primarily through traditional tests (Watt, 2005), although the use of different methods is emphasized in the curriculum (Serin, 2015). According to recent research, the prominent use of traditional tests stems from both insufficient training in other learning assessment tools (e.g. Serin, 2015) and difficulties in implementing these tools (Kim & Noh, 2010).

The majority of traditional tests include questions that require straightforward solutions which are unrelated to the students' life experiences and which generally require the application of procedures under time constraints (Dochy, 2001). Furthermore, the types of questions and the skills needed to solve them conform with traditional beliefs about the nature of mathematics (Stipek, Givvin, Salmon & MacGyvers, 2001). The assessment methods used by teachers thus seem to be influenced by their beliefs about the nature of mathematics (Morgan & Watson, 2002).

These issues raise questions about the attitudes of prospective and practicing teachers toward alternative assessment methods and their subsequent readiness to apply them. Whether and how the participation of prospective and practicing mathematics teachers in a training course on alternative assessment affects their attitudes toward assessment, their beliefs about the nature of mathematics, and the types of assessment tasks they construct were examined in the current study.

Literature Review

Assessment in Mathematics

Assessment is the process of collecting evidence regarding students' learning, interpreting the evidence, and defining an action (Black, 2013; Harlen, 2006). Earl and Katz (2006) attributed three distinctive functions to learning assessment: assessment of learning, assessment for learning, and assessment as learning. Assessment of learning is summative in nature and is designed to supply evidence of achievement to different stakeholders including the students themselves. Assessment for learning is formative in nature and used by teachers both to determine what their students know and can do and to learn about their preconceptions, confusions, and potential gaps. Teachers use this information to guide their instructional decisions and provide descriptive feedback for students. Assessment as learning is also formative and allows students to understand themselves as learners and become cognizant of how they learn.

With respect to mathematics, assessment serves purposes such as supporting the learning process (NTCM, 1989) and informing instructional decisions (Even, 2005; Stiggins, 2005). Both purposes reflect the formative nature of the learning assessment.

It is thus argued that assessment in mathematics should be made for the students and not about them (NTCM, 2000). It should not, therefore, be limited to achievement tests that summarize performance at the conclusion of the instruction (Ginsburg, 2009; Wiliam, 2007) and thus encourage students to memorize facts rather than to think actively and solve problems creatively (Kim & Noh, 2010). Given these limitations, teachers have been recommended to use a variety of alternative assessment tools, which differ from traditional assessment methods in procedures and aims (Watt, 2005). The alternative assessment based on constructive view of learning in which students, text, and context affect the learning outcome. In addition, assessment of students' learning processes is at least equally important as outcomes. Alternative assessment provides feedback about the learning process while instruction is under way and offers a more holistic view of students' learning (Janisch, Liu & Akrofi, 2007).

In the training course on alternative assessment, which was the focus of the current study, five methods of alternative assessment were primarily discussed. The first method is the concept map, which provides students with opportunities to explore the connections and interactions between mathematical topics and to understand different representations of the same idea (Novak, 2010). Through concept maps, it is possible to observe the progressive variation in the teachers' knowledge about teaching and learning mathematics (Chichekian & Shore, 2014). The second method is peer assessment, which increases learners' awareness of their strengths and weaknesses and contributes to the development of metacognitive, personal, and professional skills (e.g. Topping, 2009). Through involvement in peer assessment, learners should be able to predict their own performance, to nurture their ability to understand assessment feedback (Bloxham & West, 2004), and to improve their performances and outcomes (Mulder, Baik, Naylor & Pearce, 2014). The third method is the portfolio, which is believed to promote creative thinking, divergent thinking, recording, note-taking introspection, and reflection (McDonald, 2012). The fourth method is journal writing, a tool which has been linked to an increase in students' awareness of what they know and which helps them to link previous knowledge with newly acquired knowledge (Adu-Gyamfi, Michael & Faulconer, 2010) while promoting their metacognitive thinking (Pugalee, 2001). The use of journals also allows teachers to learn more about their students' thinking, to assess their understanding, and to provide them with feedback (Powell & Ramnauth, 1992). The fifth method is observation, by which teachers can monitor students and their work (Short, 1993). Observation also enables teachers to understand the types of interactions and classroom strategies which should influence their selection of instructional tasks that foster learning (Guernsey & Ochshorn, 2011).

Attitudes Toward Alternative Assessment

An attitude "refers to someone's basic liking or disliking of a familiar target" (Hannula, 2002, p. 25); in other words, attitude is the positive or negative degree of affect associated with a certain object (Zan & Di Martino, 2008). Despite the difficulty of the application of alternative assessment, positive attitudes toward have been reported in different studies (e.g. Beaver & Beaver, 2011; McKinney & Frazier, 2008). Research has shown that experience with alternative assessment methods has a positive effect on prospective and practicing teachers' attitudes. For example, Beaver and Beaver (2011) demonstrated that experience in peer assessment enhances prospective teachers' mathematical writing ability

and understanding of mathematical topics. Prospective teachers have, similarly, been found to consider journal writing an effective means for assessing students' understanding of mathematics and a source of support for student conceptual learning (Kenney, Shoffner & Norris, 2014). Furthermore, teachers view learning journals as a useful tool for understanding their students' thinking (Ng & Yeo, 2005). Positive attitudes toward other alternative assessment tools have also been documented; for example, portfolios have been proved a valuable tool for stimulating reflection (Mansvelder-Longayroux, Beijaard & Verloop, 2007), defining students' development, and identifying their strengths and weaknesses (Bushman & Schnitker, 1995).

Attitudes toward alternative assessment are influenced by various concerns related to its use. These mainly pertain to rubrics, grading, motivation, honesty, reliability, and validity (McKinney & Frazier, 2008; Watt, 2005), but concerns have also been voiced in relation to teachers' inadequate knowledge concerning the application of alternative assessment methods (Al-Nouh, Taqi & Abdul-Kareem, 2014; Ogan-Bekiroglue, 2009). Teachers' attitudes are also affected by class size, autonomy in the choice of assessment tools, and adequate time allocated for planning, performing, and reflecting (Good, 2011; Yu-Ching, 2008).

Teachers' Beliefs About the Nature of Mathematics

Beliefs about the nature of mathematics refer to "an individual's understandings and feelings that shape the ways the individual conceptualizes and engages in mathematics behavior" (Schoenfeld, 1992, p. 358). Teachers' beliefs about the nature of mathematics include their thoughts on personal efficacy, assessment, and group work and their perceptions of school culture, learning and teaching mathematics, and teacher preparation programs (Furinghetti & Pehkonen, 2002; Handal, 2003).

Teachers' beliefs about the nature of mathematics have been classified in the literature into different categories. Ernest (1989) proposed three categories: mathematics as a collection of facts, skills, and rules applied in different situations; mathematics as a static body of integrated pre-existing knowledge waiting for discovery; and mathematics as a creative and dynamic human invention—a process rather than a product. Alternatively, Collier (1972) (as cited in Seaman, Szydilk, Szydlik & Beam, 2005) proposed two categories: formal mathematics and informal or constructive mathematics. Stipek et al. (2001) proposed two similar categories: traditional mathematics and mathematics as inquiry-oriented (constructivist). Traditional beliefs see mathematics as a static body of knowledge that involves a series of operations and requires the performing of procedures and manipulating of symbols. According to constructivist beliefs, mathematics is conceptualized as a discipline that changes constantly, a tool for thinking and problem-solving, and a set of cultural understandings that arise from problem-solving activities (Stipek et al., 2001).

Beliefs about the nature of mathematics influence various aspects, such as teaching methods, achievement, and teaching practices (Briley, Thompson & Iran-Nejad, 2009; Hart, 2002, Stipek et al., 2001). Teachers' beliefs about the nature of mathematics affect the teaching methods they apply in their classrooms (Stein & Kim, 2008), and play a pivotal role in their interpretation of the knowledge gained through their education (Hart, 2002; Llinares, 2002; Stuart & Thurlow, 2000). More specifically, researchers have found a positive correlation between traditional positivist beliefs toward

mathematics and teaching mathematics which emphasizes procedural knowledge rather than understanding (Stipek et al., 2001; Raymond, 1997). A positive relationship was also found between constructivist beliefs about mathematics and prospective teachers' achievements in mathematics (Briley et al., 2009). Prospective teachers' teaching practices were also affected by their beliefs.

Research Goals and Questions

The reviewed literature revealed that studies on alternative assessment have tended to focus on a single method (i.e. peer assessment, concept maps, or portfolios), while studies on beliefs about the nature of mathematics have emphasized their impact across only a few mathematical domains. Scarce attention has been directed to the effect of training in alternative assessment methods on attitudes toward the use of these methods in mathematics education or to beliefs about the nature of mathematics. Furthermore, there has been little discussion about the correlation between attitudes toward alternative assessment in mathematics and beliefs about the nature of mathematics. The current study aimed to address this void by exploring the impact of participating in a training course on alternative assessment on both the attitudes of prospective and practicing mathematics teachers' toward assessment and their beliefs about the nature of mathematics and of the assessment tasks they construct. More specifically, this research addressed the following questions:

1. To what extent are teachers' attitudes toward alternative assessment related to their beliefs about the nature of mathematics?
2. To what extent do prospective and practicing teachers differ in their attitudes toward alternative assessment and beliefs about the nature of mathematics before participating in a course on alternative assessment in mathematics? Do they differ after participating in the course?
3. Does participation in a course on alternative assessment affect participants' attitudes toward alternative assessment in mathematics and beliefs about the nature of mathematics? Is the effect the same for both prospective and practicing teachers?
4. Is the change in attitudes toward alternative assessment and beliefs about the nature of mathematics reflected in the type of assessment tasks the participants subsequently set?

Method

To meet the aim and objectives of the study, we used a mixed method design with quantitative and qualitative components, which enabled a greater understanding of prospective and practicing teachers' attitudes and beliefs. The quantitative component was dominant, while the qualitative component was used to complement quantitative findings (Kelle, 2001). In the quantitative component, a quasi-experimental (pre-post) design was used to examine the effects of participating in a course about alternative assessment with an emphasis on alternative assessment on attitudes toward alternative assessment and on beliefs about the nature of mathematics. In the qualitative component, participants wrote a variety of tasks for evaluating students' mathematics learning.

The aim of this component was to examine changes in the type and content of these tasks following participation in the course. Interviews were also conducted with a subsample of the participants.

The Study

Participants took part in a course about alternative assessment consisting of 14 meetings (90 min each). The topics addressed in the course included the following: the standards and principles of assessment in mathematics, formative and summative assessments, and alternative assessment methods (concept maps, peer assessment, portfolios, learning journals, and observation). Throughout the course, participants engaged in several activities such as follows: constructing concept maps about several concepts (e.g. functions, fractions, shapes); practicing peer assessment through several tasks related to ratio and proportion; constructing a rubric for rich content mathematical problems and assessing the performance of a group of elementary pupils using the rubric; constructing formative questions; discussing the questions on international mathematical tests, such as the TIMSS and the PISA tests, and large-scale tests conducted in Israel. More details about the intervention are presented in Appendix A.

Participants

Data were collected from 51 prospective teachers and 50 practicing mathematics teachers in a master's degree program at two education colleges in Israel. Both groups participated in a course on alternative assessment in mathematics education. A description of the participants' background is displayed in Table 1. As can be seen, the vast majority of the participants are female, most are trained in education colleges, and only 40% have advanced high school mathematics. They showed great diversity in terms of experience.

Research Tools and Variables

Data were obtained using a questionnaire (Appendix B), assessment tasks related to mathematical concepts, and semi-structured interviews.

The Questionnaire The questionnaire consisted of three parts. The first part included background questions on gender, high school education, and experience in alternative assessment as a student or teacher. The second part of the questionnaire included five items aimed at measuring attitudes toward methods of alternative assessment. These items were adopted from existing questionnaires and adapted to suit the study participants (e.g. Ogan-Bekiroglue, 2009; Watt, 2005; Wen & Tsai, 2006). Responses to these items were given on a five-point Likert-type scale where *1* indicates the least positive attitude and *5* the most positive attitude (example item: alternative assessment methods help students in their learning process). Cronbach's α values for the pre- and post-scores were = .824 and .675, respectively. The third part included 31 items designed to measure participants' beliefs about the nature of mathematics. These items were adapted to suit the current study from the questionnaire of Stipek et al. (2001), which examines traditional beliefs in contrast to inquiry-oriented beliefs about mathematics (example item: mathematical ability is

Table 1 Distribution of the participants according to background variables

Variable	Categories	Practicing teachers	Prospective teachers
Gender	Female	88%	88.2%
	Male	12%	11.8%
Level of mathematics at high school	Basic	8%	10%
	Intermediate	52%	30%
	Advanced	40%	60%
Learned a course on alternative assessment during teacher training	Yes	20%	–
	No	80%	–
Teacher training institution	College	80%	–
	University	20%	–
Teaching experience	1–5 years	32%	–
	5–10 years	28%	–
	11–16 years	24%	–
	More than 17 years	16%	–
Current school	Elementary	44.9%	–
	Secondary	55.1%	–

something that remains relatively fixed throughout a person's life), and from Zollman and Mason's (1992) Standard Beliefs Instrument (SBI), which measures beliefs about the standards of the National Council of Teachers of Mathematics (example item: it is more important to assess students' reasoning in mathematical problem-solving than their accuracy). Responses to items in this part of the questionnaire were given on a five-point Likert scale where *1* indicates strong disagreement and *5* strong agreement. Two index scores were calculated: the first was based on responses to 21 items that reflect positivist beliefs and the second on responses to 10 items that reflect constructivist beliefs. Values of Cronbach's α for the positivist and constructivist scales were .80 and .66, respectively.

Assessment Tasks In the first and the last meeting of the course, the participants were required to write assessment tasks evaluating students' learning about percentages. The rationale for using assessment tasks was to examine whether changes in participants' attitudes toward alternative assessments and beliefs about the nature of mathematics would be reflected in the type of assessment tasks they designed. The choice to focus on the topic of percentages stemmed from both its centrality in the mathematics curriculum at all school levels and the fact that its learning involves procedural performance as well as comprehension of diverse aspects.

The Interview A semi-structured interview was conducted with 10 randomly selected participants, 5 prospective and 5 practicing teachers. Interviewees were presented with five general questions on the nature of mathematics and assessment in mathematics; for example, what does it look like when students are doing mathematics? What should we assess in mathematics? How often should we assess students in mathematics?

Interviewees were subsequently asked to respond to more specific questions regarding these aspects of mathematics; for example, what alternative assessment methods should be used to evaluate learning in mathematics? The interviews were conducted face-to-face by one of the researchers in a convenient setting for the interviewees. Interviewing time was not limited, and probe questions were posed when needed.

Figure 1 summarizes the research tools measured both before and after the course.

Procedure

At the first meeting of a course on alternative assessment in mathematics, the questionnaire was administered to participants (prospective and practicing mathematics teachers), they were also asked to write assessment tasks relating to the concept of percentages. In the last meeting, they were once again required to fill in the questionnaire and write assessment tasks. Data collected before and after the course were used to assess the effect of the intervention on participants' attitudes and beliefs and on the types of assessment tasks they suggested.

Data Analyses

Quantitative Data SPSS version 21 was used to analyze the quantitative data. The effect of participating in a course on alternative assessment in mathematics was examined by paired and independent samples *t* tests. In addition, the correlations between attitudes toward alternative assessment and beliefs about the nature of mathematics both before and after the course were calculated, and differences between the two research groups before and after the course were examined in terms of gain scores by means of *t* test.

Assessment Tasks Data Based on existing literature, the qualitative data obtained from the assessment tasks were classified into two main types:

(1). *Traditional tasks*. Tasks related to percentages were defined as traditional in four cases according to Parker and Leinhardt (1995) classification or common task according to Van den Heuvel-Panhuizen (1994):

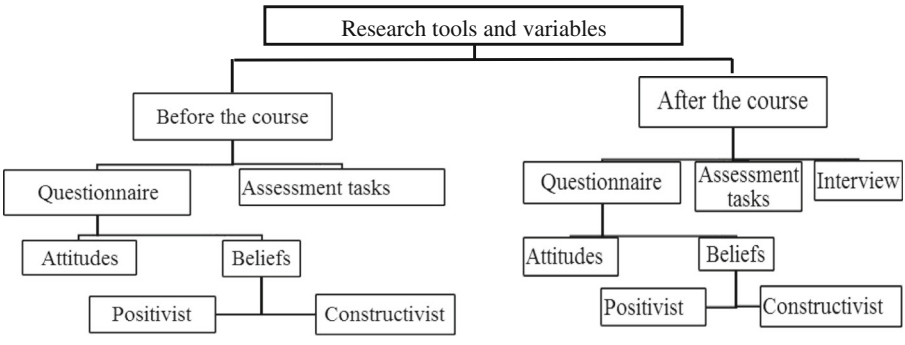

Fig. 1 Summary of the research tools and variables

(a). Conversion exercises: Tasks that require performing transformations in three notational systems—percentage, fractions, and decimals; for example, converting .13 or into a percentage.
(b). "So many out of so many" exercises: Tasks that require finding three options; for example, the base (e.g. 15% of? = 20).
(c). Shading tasks: Tasks that require students to shade part of a continuous region or a set of discrete objects.

d.1 Traditional word problems: Applied situations, usually containing percentages, that require extracting the relevant information and finding a solution. This type of task generally requires implementing simple procedures.
d.2 Meaningful and informative word problems/conceptual word problems: Word problems are classified as meaningful when they require conceptual understanding of the percentage concept (Van den Heuvel-Panhuizen, 1994). For example:

– Change in the referent quantity leads to change in the percentage (e.g. if the price of an item has increased by 25% and is then decreased by 25%, will the price of that item be the same as its original price?

(2). *Alternative assessment tasks* (see Fig. 2). These tasks require the application of conceptual understanding of the percentage concept. Several types of alternative assessment methods were reviewed earlier. For example:

(a). Constructing a concept map related to the percentage concept;
(b). Writing a scenario involving percentages while utilizing specific data and constraints (e.g. a word problem using the following terms and numbers: 20%, 200, perfume).

Interviews Data The qualitative data obtained from the interviews were subjected to thematic content analysis. Meaning units were extracted and organized into categories,

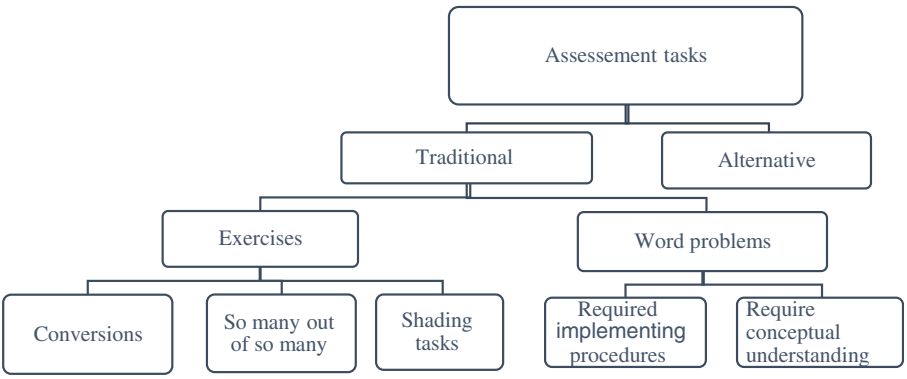

Fig. 2 Types of assessment tasks

and these evolving categories were grouped into meaningful clusters (Coffey & Atkinson, 1996; Patton, 2002) (see Table 2).

Results

Relationship Between Attitudes and Beliefs

The first research question addressed the relationship between participants' attitudes toward alternative assessment and their beliefs about the nature of mathematics. The correlations were examined both before and after participation in the course on alternative assessment. Results pertaining to both prospective teachers and practicing teachers are presented in Table 3.

These results reveal a somewhat different pattern of correlations between attitudes and beliefs of prospective and practicing mathematics teachers both before and after the course. Before the course, the correlations between prospective teachers' attitudes toward alternative assessment and both positivist and constructivist beliefs were positive, low in magnitude, and statistically not significant. The correlation between positivist and constructivist beliefs was also found to be positive and low. For practicing teachers, the correlation between attitudes toward alternative assessment and positivist beliefs was also positive but with lower magnitudes than prospective teachers, while the correlation between attitudes and constructivist beliefs was found negative, low in magnitude, and not significant.

Furthermore, a negative correlation with medium magnitude was found between practicing teachers' positivist and constructivist beliefs compared a low positive correlation between these two variables among prospective teachers.

Table 2 Examples of interview analyses

Cluster	Categories	Examples of participants' statements
Alternative assessment can foster different students' abilities	Creative thinking	"Some of the alternative methods such as concept maps lead students to think in different ways. There will be different maps for the same concepts. They think in creative ways through constructing the maps."
	Writing in mathematics	"Throughout the course, I understood how much writing is a good way in mathematics to assess students' understanding. Some assessment methods that I learned could promote students' writing."
	Reflective thinking	"Students who engage in peer assessment consider their thinking or their solutions and will be aware of their mistakes."
	Communication	"Alternative assessment allows students to express themselves in different ways. This opportunity doesn't exist in the traditional tests."

Table 3 Pearson correlations between prospective (n = 51) and practicing (n = 50) mathematics teacher's attitudes toward alternative assessment and beliefs about mathematics

	Variable	Pre			Post		
		Attitudes toward alternative assessment	Positivist beliefs	Constructivist beliefs	Attitudes toward alternative assessment	Positivist beliefs	Constructivist beliefs
Pre	Attitudes toward alternative assessment	–	.102	−.205			
	Positivist beliefs	.256	–	−.408**			
	Constructivist beliefs	.210	.089	–			
Post	Attitudes toward alternative assessment				–	−.293	.027
	Positivist beliefs				−.050	–	−.542**
	Constructivist beliefs				.267	−.389**	–

Correlations below diagonals correspond to prospective teachers and above diagonals to practicing teachers

After the course, some differences were also detected between prospective and practicing teachers in terms of the correlations between attitudes and beliefs. A more salient negative correlation between attitudes toward alternative assessment and positivist beliefs about nature of mathematics and a less salient positive correlation between attitudes and constructivist beliefs were found among practicing teachers compared to their prospective counterparts. Meanwhile, the correlation between positivist and constructivist beliefs was found to be negative for both groups but larger among practicing teachers.

Differences Between Prospective and Practicing Teachers' Attitudes and Beliefs

The second research question focused on the differences between prospective and practicing teachers in their attitudes and beliefs before and after the course. This question was addressed by using independent samples t test and the results are summarized in Table 4.

Results in Table 4 show that before the course there was a significant difference between the two groups in their attitudes toward alternative assessment. Practicing teachers reported more positive attitudes than prospective teachers; the significant difference is featured by a medium effect size (Cohen's d = .43). No significant differences were found between the two groups in terms of their beliefs about mathematics. With respect to differences between the two groups after the course, no

Table 4 Mean, SD, and results of independent samples *t* test (*t* values and Cohen's *d*) for comparison between prospective ($n = 46$) and practicing teachers ($n = 50$) in terms of their attitudes and beliefs of before and after the course

Variables	Group	*n*	Mean	SD	*t*	Cohen's *d*
Before the course						
Attitudes toward alternative Assessment	Prospective teachers	51	3.97	.73	−2.12*	−.43
	Practicing teachers	50	4.26	.63		
Positivist beliefs	Prospective teachers	51	2.95	.51	1.72	.36
	Practicing teachers	50	2.77	.49		
Constructivist beliefs	Prospective teachers	51	3.72	.45	−.76	−.15
	Practicing teachers	50	3.79	.47		
After the course						
Attitudes toward alternative assessment	Prospective teachers	46	4.53	.43	.36	−.09
	Practicing teachers	43	4.49	.45		
Positivist beliefs	Prospective teachers	46	2.54	.55	1.91	.38
	Practicing teachers	50	2.35	.45		
Constructivist beliefs	Prospective teachers	46	4.03	.45	−1.35	−.28
	Practicing teachers	50	4.18	.60		

*$p < .05$

significant differences were found in either their attitudes toward alternative assessment or their beliefs about mathematics.

The Effects of the Course on Alternative Assessment

The third research question focused on whether participation in a course on alternative assessment affects attitudes and beliefs of participants and whether this is the same for both prospective and practicing teachers. The first part of this question was examined by conducting paired (dependent) *t* test on the data for prospective and practicing teachers separately and the results are presented in Table 5.

The results reveal significant differences in attitudes and beliefs before and after participation in the course among both prospective and practicing teachers. More specifically, attitudes toward alternative assessment became more positive. Meanwhile, participation in the course seemed to strengthen constructivist beliefs while weakening positivist beliefs about nature of mathematics. The significant differences were also featured with medium to high effect size values. The pattern of the results was similar for both prospective and practicing teachers, except for the effect size corresponding to attitudes which was larger for prospective teachers (1.06 and .049 for prospective and practicing teachers, respectively).

The second part of the third research question was addressed by examining the difference between prospective and practicing teachers in terms of the gain score in attitudes toward alternative assessment. The difference between the two groups was found significant in favor of the prospective teachers (prospective teachers: mean change (gain score) = .62, SD = .74; practicing teachers: mean change = .27, SD = .78;

Table 5 Mean, SD, and results of paired *t* test (*t* values and Cohen's *d*) for prospective ($n = 51$) and practicing teachers ($n = 50$)

Variable	*n*	Mean	SD	*t*	Cohen's *d*
Prospective teachers					
Attitude—pre	46	3.90	.72	5.68***	1.06
Attitude—post		4.52	.43		
Positivist beliefs—pre	46	2.92	.52	−5.4***	−.71
Positivist beliefs—post		2.54	.55		
Constructivist beliefs—pre	46	3.70	.46	4.67***	.73
Constructivist beliefs—post		4.03	.45		
Practicing teachers					
Attitude—pre	43	4.22	.64	5.23*	.49
Attitude—post		4.49	.45		
Positivist beliefs—pre	50	2.77	.49	−6.87***	−.89
Positivist beliefs—post		2.35	.45		
Constructivist beliefs—pre	50	3.79	.47	6.34***	.72
Constructivist beliefs—post		4.18	.60		

*$p < .05$; ***$p < .001$

$t = 2.19$* $p < .05$). No significant differences were found between the two groups with regard to positivist beliefs (prospective teachers: mean change = .38, SD = .47; practicing teachers: mean change = .42, SD = .43; $t = .51$) and constructivist beliefs (prospective teachers: mean change = .32, SD = .47; practicing teachers: mean change = .39, SD = .43; $t = .75$).

The change in attitudes toward alternative assessment was emphasized in the interviews at the end of the learning process. Prospective and practicing teachers indicated their willingness to use alternative assessment and stated several reasons:

1. *Alternative assessment reveals students' conceptual understanding of mathematical concepts more than traditional tests.* Some interviewees indicated that in traditional tests students might even memorize procedures and apply them without conceptual understanding. This argument is evident in the following statement from one of the interviewees: "students can get a complete grade on the traditional test; they can apply the procedure without understanding. For example, there were students who got high grades in the traditional test about squares, but they don't know the relationship between squares and other shapes."
2. *Alternative assessment can provide students with an opportunity to demonstrate their true ability.* Some interviewees indicated that traditional tests are not able to reveal the true student's ability for many reasons such as test anxiety. As one of the participants noted: "I remember myself, when I was in school, every test I got afraid and forgot some of the test material or some of the methods, and so there are students like me."
3. *Alternative assessment can reflect all of the learning process and not only the product.* Some interviewees indicated that because the traditional test is usually

conducted at the end of the learning process, the assessment is about the product; the use of alternative assessments, like portfolios, on the other hand, offers an opportunity to assess all of the learning process. This reasoning is exemplified in the following quotation: "some students learned only for the final test and didn't do their homework or participate in the tasks in class. By using the portfolio, they will know that studying for the final test isn't enough."

4. *Alternative assessment can foster different students' abilities.* Some interviewees indicated that the use of alternative assessment can help foster different students' abilities, such as the ability to express one's self and communicate through problem-solving tasks. This was explained in the following statement: "We give students an opportunity to express themselves and to use their own words; now I am ready to assess students' learning this way. Without the use of numbers, students learn to express themselves in several ways."
5. *Alternative assessment can promote better relationships between teachers and students.* Some interviewees indicated that the use of alternative assessment can promote closer social relationships between teachers and students. Teachers who employ alternative assessment can learn more important things about their students, as stated by one of the participants: "alternative assessment allows students to be closer to you; you will find out things that you cannot know through the traditional test."
6. *Alternative assessment is more equitable.* Some interviewees indicated that the use of different methods of assessment can be fairer as disparities between students require different assessment methods. One of the interviewees explained: "certain methods are more appropriate for some students and can reveal their thinking and creativity."

The Relationship Between Changes in Attitudes and Types of Assessment Tasks

The fourth research question focused on whether positive changes in attitudes toward alternative assessment and in constructivist beliefs are complemented by a change in the nature of the assessment tasks that the participants wrote. This was examined by defining two groups: the first group included participants who displayed a positive change in their attitudes and beliefs and the second group participants who displayed negative or no change in both variables. The two groups were compared in terms of the percentages of different types of assessment tasks they wrote before and after the course, the results are presented in Table 6.

These results indicate that the change in attitudes toward alternative assessment and beliefs about the nature of mathematics were reflected in the nature and types of assessment. Participants with positive changes in attitudes and beliefs demonstrated a greater change in the nature and type of assessment tasks than participants with negative or no change.

The increase in the percentage of conceptual alternative assessment tasks and the reduction in the percentage of exercises and procedural tasks are more salient among prospective teachers. Examples of traditional and alternative assessment tasks written by participants are presented in Table 7.

Table 6 Distribution of participants reporting positive change in attitudes and constructivist beliefs and participants reporting negative or no change according to types of assessment tasks

Measure	Group 1 = participants with positive change in attitudes and constructive beliefs (n = 35)				Group 2 = participants with negative or no change in attitudes and constructive beliefs (n = 36)			
	Traditional assessment			Alternative assessment	Traditional assessment			Alternative assessment
	Exercises	Word problems			Exercises	Word problems		
		Procedural	Conceptual			Procedural	Conceptual	
Before the course	34	72	2	0	29	57	18	4
	31.3%	66.6%	2%	0%	26.9%	52.7%	16.7%	3.7%
After the course	11	22	64	23	10	35	47	11
	9.2%	18.3%	53.3%	19.2%	9.7%	34%	45.6%	10.7%

Table 7 Examples of traditional and alternative tasks

Task type	Subtype	Example
Traditional assessment	Exercises	How much is 50% of 800?
	Procedural word problems	Ahmad wants to buy a book. The initial price of the book is 40 ILS and there is a discount of 20%. How much should he pay?
	Conceptual word problems	There are three shops. The first offers a 70% discount, the second 75%, and the third 25%. If you want to buy a product, where is it cheaper? Explain.
Alternative assessment		Build a concept map for the percentage concept.

Discussion

The aim of the current study was to explore the effect of participating in a course on alternative assessment methods on prospective and practicing teachers' attitudes toward alternative assessment and their beliefs about mathematics. At the outset, we examined the relationship between these attitudes and beliefs in order to assess researchers' claims regarding a positive correlation between attitudes toward alternative assessment and the constructivist component of beliefs about the nature of mathematics. Our findings indicated that, on the whole, there are no correlations between attitudes and either of the positivist or constructivist components of beliefs about the nature of mathematics before or after participating in the course. These findings are not in line with those of García-Ros and Pérez-González (2011) who indicated that an association exists between the preference for non-conventional procedures and a deep learning style that reflects constructivist approach. However, teachers' endorsement of constructivist beliefs about mathematics does not necessarily relate to positive attitudes toward alternative assessment due to possible constraints and difficulties they encounter when applying this type of assessment in the classroom.

An interesting finding relates to the significant negative correlation between the positivist and constructivist components of beliefs about mathematics that was found among practicing teachers following their participation in the course. This correlation suggests that the learning process could help active teachers to sharpen their beliefs and define their perceptions more clearly while strengthening their constructivist beliefs. It seems that due to the learning process and the knowledge and skills they acquired through participation in the course on alternative assessment, practicing teachers demonstrate clearer and more identifiable beliefs than prospective teachers. This can be attributed to their additional experience and the knowledge they acquired through participating in the course.

The findings indicated no significant differences between prospective and practicing teachers in terms of their attitudes and beliefs except regarding their attitudes toward alternative assessment before the course with practicing teachers reporting more positive attitudes than prospective teachers. These finding are consistent with Birenbaum and Rosenau (2006), who found no significant difference between practicing and prospective teachers regarding their preference for non-conventional assessment, and Wen, Tsai and Chang (2006), who found that practicing teachers were more positive

toward peer assessment, which they saw as a learning aid than prospective teachers. The difference between the two groups can be attributed to practicing teachers' more comprehensive knowledge about different modes of assessments including their advantages and disadvantages. They are likely to have gained some of this knowledge from their experience in teaching and assessment and from professional development.

No significant differences were found in attitudes and beliefs before and after participation in the course among prospective and practicing teachers separately. More specifically, following participation in the course, attitudes toward alternative assessment became more positive, while participation in the course was shown to strengthen constructivist beliefs while weakening positivist beliefs about mathematics in both groups. This concurs with Gijbels and Dochy's (2006) findings that after experience with formative assessment, there is a significant negative relationship between a deep approach to learning and a preference for teacher-made tests. The change in both attitudes and beliefs demonstrates that learning about new methods of assessment through participating in a course results in a change in the desired direction; namely, positive changes in attitudes toward alternative assessment and constructivist beliefs and negative changes in positivist beliefs. These findings support somewhat Gielen, Dochy and Dierick's (2000) assertion that knowledge of new assessments methods encourages the use of advanced cognitive and metacognitive strategies. The contribution of the experience in alternative assessment to positive attitudes has been emphasized in various studies (e.g. Baeten, Dochy & Struyven, 2008b; Beaver & Beaver, 2011; Wen & Tsai, 2006).

The findings from the interviews revealed an interesting connection between the reasons for participants' willingness to use alternative assessment and several facets of didactical suitability criteria: cognitive, emotional, interactional, mediational, and ecological, as proposed by the Onto-Semiótico Approach (OSA) and documented in different publications (e.g. Godino, Batanero, Font, Contreras & Wilhelmi, 2016; Pino-Fan, Godino & Font, 2016). Participants indicated that alternative assessment shows students conceptual understanding of mathematical concepts and can provide students with the opportunity to demonstrate their true ability. This relates to students' cognitive facet that reflects their levels of development, understanding of strategies, and difficulties handling the intended content. Participants' assertion that alternative assessment can reflect all the learning process and not only the product relates to interactional suitability which refers to the knowledge of the interactions that occur within a classroom. The claim that alternative assessment can promote better relationships between teachers and students relates to the affective facet which involves the knowledge about the students' affective, emotional, and behavioral aspects. Two additional reasons explaining why alternative assessment is more equitable and can foster different students' abilities relate to the cognitive, emotional, and interactional facets simultaneously.

The change in the type of assessment tasks that prospective and practicing teachers suggested following their participation in the course is one of the most interesting findings of the current study. This change was evident among participants from both groups—those with a positive change in attitudes and in constructive beliefs and those with negative or no change in both attitudes and constructive beliefs. Both groups offered more conceptual and alternative problems and fewer exercises and procedural problems, revealing that assessment preference is not stable and can be changed by new knowledge and experience in alternative assessment methods. This interpretation is supported by Baeten, Dochy and Struyven (2008a) who found significant correlations

between a deep approach to learning and a preference for tasks that require higher-order thinking and for permanent evaluation both before and after experience with portfolio assessment. The increase in the proportion of conceptual tasks also indicates that the positive changes in attitudes and in constructivist beliefs were complemented by a change in the participants' assessment behavior. This finding implies that under certain circumstances, attitudes and beliefs can actually translate into behaviors or actions. However, the modest change in the type of assessment tasks that was evident in the practicing group may reflect their experience in real classroom circumstances where various factors (such as class size, school working conditions, and assessment policy) restrict teachers, even those with positive attitudes and constructivist beliefs, from implementing alternative assessment methods.

Despite the modest changes detected in the current study following participation in a course on alternative assessment in mathematics, the findings provide evidence of the effectiveness of the course as a means for changing attitudes toward assessment in mathematics and beliefs about the nature of the mathematical knowledge and thus support the call to integrate assessment courses that emphasize alternative assessment methods in the training process of mathematics teachers. Professional development interventions should also include training in alternative assessment and its appropriate application. The positive attitudes of prospective and practicing teachers toward alternative assessment and their willingness to apply this method of assessment should be backed by the necessary conditions, such as continuing professional development, reasonable class sizes, and a suitable organizational assessment culture and orientation that enables and encourages teachers to implement alternative assessment methods.

Despite the importance of the current study and the interesting and useful findings it yielded, it is not free of limitations. First, the small sample of participants, due to the constraint of a long intervention program, may present a limitation concerning the generalizability of the research findings. In addition, we did not constrain the number of tasks that participants were required to write in order to assess students' learning of the percentage concept. It is also important to examine changes in teachers' assessment practices in the real classroom setting following participation in professional development activities on learning assessment. It is worth noting that in this pioneering study, some parts of the data analysis are descriptive in nature and thus cannot reflect the complexity of the addressed topic. Future comprehensive research is needed to address the limitations of the current study and to follow-up with pertinent issues including an examination of nonlinear relationships among attitudes toward alternative assessment methods and beliefs about mathematics.

References

Adu-Gyamfi, K. B., Michael, J., & Faulconer, J. (2010). Assessing understanding through reading and writing in mathematics. *International Journal for Mathematics Teaching & Learning, 11*(5), 1–22.

Al-Nouh, N. A., Taqi, H. A., & Abdul-Kareem, M. M. (2014). EFL primary school teachers' attitudes, knowledge and skills in alternative assessment. *International Education Studies, 7*(5), 68–84.

Baeten, M., Dochy, F., & Struyven, K. (2008a). Students' approaches to learning and assessment preferences in a portfolio-based learning environment. *Instructional Science, 36*(5–6), 359–374.

Baeten, M., Dochy, F., & Struyven, K. (2008b). The effects of hands-on experience on students' preferences for assessment methods. *Journal of Teacher Education, 59*(1), 69–88.

Beaver, C., & Beaver, S. (2011). The effect of peer-assessment on the attitudes of pre-service elementary and middle school teachers about writing and assessing mathematics. *Teacher Attributes, 5*, 1–14.

Birenbaum, M., & Rosenau, S. (2006). Assessment preferences, learning orientations, and learning strategies of pre-service and in-service teachers. *Journal of Education for Teaching: International Research and Pedagogy, 32*(2), 213–225.

Black, P. (2013). Formative and summative aspects of assessment: Theoretical and research foundations in the context of pedagogy. In J. McMillan (Ed.), *Sage handbook of research on classroom assessment* (pp. 167–178). London, UK: SAGE Publications.

Bloxham, S., & West, A. (2004). Understanding the rules of the game: Marking peer assessment as a medium for developing students' conceptions of assessment. *Assessment & Evaluation in Higher Education, 29*(6), 721–733.

Briley, J. S., Thompson, T., & Iran-Nejad, A. (2009). Mathematical beliefs, self-regulation, and achievement by university students in remedial mathematics course. *Research in the School, 16*(2), 15–28.

Bushman, L., Schnitker, B. (1995). *Teacher attitudes on portfolio assessment, implementation, and practicability.* (ERIC Document Reproduction Service No. ED388661).

Chichekian, T., & Shore, B. M. (2014). Concept maps provide a window onto pre-service elementary teachers' knowledge in the teaching and learning of mathematics. *Canadian Journal of Education/Revue canadienne de l'éducation, 36*(3), 47–71.

Coffey, A., & Atkinson, P. (1996). *Making sense of qualitative data: Complementary research strategies*. Thousand Oaks, CA: Sage.

Collier, C. P. (1972). Prospective Elementary teachers' intensity and ambivalence of beliefs about mathematics and mathematics instruction. *Journal for Research in Mathematics Education, 3*(3), 155–163.

Dochy, F. (2001). A new assessment era: Different needs, new challenges. *Learning and Instruction, 10*(1), 11–20.

Earl L, M Katz (2006) Rethinking classroom assessment with purpose in mind: Assessment FOR, as and of Learning, Manitoba Education, ISBN 0–7711–3499-1, accessed at http://www.edu.gov.mb.ca/k12/assess/wncp/full_doc.pdf

Ernest, P. (1989). The impact of beliefs on the teaching of mathematics. In P. Ernest (Ed.), *Mathematics teaching: The state of the art* (pp. 249–253). New York, NY: Falmer.

Even, R. (2005). Using assessment to inform instructional decisions: How hard can it be? *Mathematics Educational Research Journal, 17*(3), 51–67.

Furinghetti, F., & Pehkonen, E. (2002). Rethinking characterizations of beliefs. In G. C. Leder, E. Pehkonen, & G. Toerner (Eds.), *Beliefs: A hidden variable in mathematics education?* (V.31, pp. 39–57). Springer Netherlands: Kluwer Academic Publishers.

García-Ros, R., & Pérez-González, F. (2011). Assessment preferences of pre-service teachers: Analysis according to academic level and relationship with learning styles and motivational orientation. *Teaching in Higher Education, 16*(6), 719–731.

Gielen, S., Dochy, F., & Dierick, S. (2000). Evaluating the consequential validity of new modes of assessment: The influence of assessment on learning including pre-, post-, and true assessment effects. In M. Segers, F. Dochy, & E. Cascallar (Eds.), *Optimizing new modes of assessment: In search of qualities and standards* (pp. 37–54). Dordrecht, The Netherlands: Kluwer.

Gijbels, D., & Dochy, F. (2006). Students' assessment preferences and approaches to learning: Can formative assessment make a difference? *Educational Studies, 32*(4), 399–409.

Ginsburg, H. P. (2009). The challenge of formative assessment in mathematics education: Children's minds, teachers' minds. *Human Development, 52*, 109–128.

Godino, J. D., Batanero, C., Font, V., Contreras, A. & Wilhelmi, M. R. (2016). *The theory of didactical suitability: Networking a system of didactics principles for mathematics education from different theoretical perspectives.* Paper presented at 13th International Congress on Mathematical Education, Hamburg, Germany. Retrieved October 2, 2016 from http://enfoqueontosemiotico.ugr.es/documentos/icme13/TSG51_suitability_ICME13.pdf.

Good, R. (2011). Formative use of assessment information: It's a process, so let's say what we mean. *Practical Assessment Research & Evaluation, 16*(3), 1–6.

Guernsey, L., & Ochshorn, S. (2011). *Watching teachers work: Using observation tools to promote effective teaching in the early years and early grades*. Washington, DC: New America Foundation.

Handal, B. (2003). Teachers' mathematical beliefs: A review. *The Mathematics Educator, 13*(2), 47–57.

Hannula, M. (2002). Attitude toward mathematics: Emotions, expectations and values. *Educational Studies in Mathematics, 49*, 25–46.

Harlen, W. (2006). On the relationship between assessment for formative and summative purposes. In J. Gardner (Ed.), *Assessment and learning* (pp. 61–80). London, UK: Sage Publications Ltd.

Hart, L. C. (2002). Pre-service teachers' beliefs and practice after participating in an integrated content/methods course. *School Science and Mathematics, 102*(1), 4–14.

Janisch, C., Liu, X., & Akrofi, A. (2007). Implementing alternative assessment: Opportunities and obstacles. *The Educational Forum, 71*(3), 221–230.

Kelle, U. (2001). Sociological explanations between micro and macro and the integration of qualitative and quantitative methods [43 paragraphs]. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research, 2*(1), Art. 5. Retrieved October 10, 2016 from http://www.qualitative-research.net/fqs-texte/1-01/1-01kelle-e.htm.

Kenney, R., Shoffner, M., & Norris, D. (2014). Reflecting on the use of writing to promote mathematical learning: An examination of preservice mathematics teachers' perspectives. *The Teacher Educator, 49*(1), 28–43.

Kim, M. K., & Noh, S. (2010). Alternative mathematics assessment: A case study of the development of descriptive problems for elementary school in Korea. *Eurasia Journal of Mathematics, Science and Technology Education, 6*(3), 173–186.

Llinares, S. (2002). Participation and reification in learning to teach: The role of knowledge and beliefs. In G. C. Leder, E. Pehknonen, & G. Torner (Eds.), *Beliefs: A hidden variable in mathematics education?* (pp. 195–209). Dordrecht, The Netherlands: Kluwer Academic.

Mansvelder-Longayroux, D. D., Beijaard, D., & Verloop, N. (2007). The portfolio as a tool for stimulating reflection by student teachers. *Teaching and Teacher Education, 23*(1), 47–62.

McDonald, B. (2012). Portfolio assessment: Direct from the classroom. *Assessment & Evaluation in Higher Education, 37*(3), 335–347.

McKinney, S., & Frazier, W. (2008). Embracing the principles and standards for school mathematics: An inquiry into the pedagogical and instructional practices of mathematics teachers in high-poverty middle schools. *The Clearing House: A Journal of Educational Strategies, Issues and Ideas, 81*(5), 201–210.

Morgan, C., & Watson, A. (2002). The interpretative nature of teachers' assessment of students' mathematics: Issues for equity. *Journal for Research in Mathematics Education*, *33*(2), 78–110.

Mulder, R., Baik, C., Naylor, R., & Pearce, J. (2014). How does student peer review influence perceptions, engagement and academic outcomes? A case study. *Assessment and Evaluation in Higher Education, 39*(6), 57–677.

National Council of Teachers of Mathematics [NCTM] (1989). *Curriculum and evaluation standards for school mathematics*. Reston, VA: NCTM.

National Council of Teachers of Mathematics [NCTM] (1995). *Assessment standards for school mathematics*. Reston, VA: NCTM.

National Council of Teachers of Mathematics [NCTM] (2000). *Principles and standards for school mathematics*. Reston, VA: NCTM.

Ng, J. D. C. H., & Yeo, S. M. (2005). *Using journal writing to understand primary three students' perception of multiplication and division: Case studies*. Paper presented at the International Conference on Education, Redesigning Pedagogy: Research, Policy, Practice, National Institute of Education, Singapore. Centre for Research in Pedagogy and Practice, National Institute of Education.

Novak, J. D. (2010). Learning, creating, and using knowledge: Concept maps as facilitative tools in schools and corporations. *Journal of e-Learning and Knowledge society, 6*(3), 21–30.

Ogan-Bekiroglue, F. (2009). Assessing assessment: Examination of pre-service physics teachers' attitudes towards assessment and factors affecting their attitudes. *International Journal of Science Education, 31*(1), 1–39.

Parker, M., & Leinhardt, G. (1995). Percent: A privileged proportion. *Review of Educational Research, 65*(4), 421–481.

Patton, M. Q. (2002). *Qualitative research and evaluation methods*. Thousand Oaks, CA: Sage.

Pino-Fan, L., Godino, J. D., & Font, V. (2016). Assessing key epistemic features of didactic-mathematical knowledge of prospective teachers: The case of the derivative. *Journal of Mathematics Teacher Education*. doi: 10.1007/s10857-016-9349-8 .

Powell, A. B., & Ramnauth, M. (1992). Beyond questions and answers: Prompting reflections and deepening understandings of mathematics using multiple-entry logs. *For the Learning of Mathematics, 12*(2), 12–18.

Pugalee, D. (2001). Writing, mathematics, and metacognition: Looking for connections through students' work in mathematical problem solving. *School Science and Mathematics, 101*(5), 236–244.

Raymond, A. M. (1997). Inconsistency between a beginning elementary school teacher's mathematics beliefs and teaching practice. *Journal for Research in Mathematics Education, 28*, 550–576.

Schoenfeld, A. H. (1992). Learning to think mathematically: Problem solving, metacognition, and sense making in mathematics. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 334–370). New York, NY: Macmillan.

Seaman, C. J., Szydilk, J. S., Szydlik, S. D., & Beam, J. (2005). A comparison of pre-service elementary teachers' beliefs about mathematics and teaching mathematics: 1968 and 1998. *School Science and Mathematics, 105*(4), 197–210.

Serin, G. (2015). Alternative assessment practices of a classroom teacher: Alignment with reform-based science curriculum. *Eurasia Journal of Mathematics, Science & Technology Education, 11*(2), 277–297.

Short, D. J. (1993). Assessing integrated language and content instruction. *Teachers of English to Speakers of Other Languages, Inc. (TESOL), 27*(4), 627–656.

Stein, M. K., & Kim, G. (2008). The role of mathematics curriculum materials in large-scale urban reform: An analysis of demands and opportunities for teacher learning. In J. Remillard (Ed.), *Teachers' use of mathematics curriculum materials: Research perspectives on relationships between teachers and curriculum* (pp. 37–55). New York, NY: Routledge.

Stiggins, R. J. (2005). From formative assessment to assessment for learning: A path to success in standards-based schools. *Phi Delta Kappan, 85*(4), 324–328.

Stipek, D. J., Givvin, K. B., Salmon, J. M., & MacGyvers, V. L. (2001). Teachers' beliefs and practices related to mathematics instruction. *Teaching and Teacher Education, 17*, 213–226.

Stuart, C., & Thurlow, D. (2000). Making it their own: Pre-service teachers' experiences, beliefs, and classroom practices. *Journal of Teacher Education, 51*(2), 113–121.

Topping, K. J. (2009). Peer assessment. *Theory Into Practice, 48*(1), 20–27.

Van den Heuvel-Panhuizen, M. (1994). Improvement of (didactical) assessment by improvement of problems: An attempt with respect to percentage. *Educational Studies in Mathematics, 27*, 341–372.

Watt, H. M. G. (2005). Attitude to the use of alternative assessment methods in mathematics: A study with secondary mathematics teachers in Sydney, Australia. *Educational Studies in Mathematics, 58*, 21–44.

Wen, L. M., & Tsai, C. C. (2006). University students' perceptions of and attitudes toward (online) peer assessment. *Higher Education, 51*, 27–44.

Wen, L. M., Tsai, C. C., & Chang, C. Y. (2006). Attitudes towards peer assessment: A comparison of the perspectives of pre-service and in-service teachers. *Innovations in Education and Teaching International, 43*(1), 83–92.

Wiliam, D. (2007). Keeping learning on track: Classroom assessment and the regulation of learning. In F. K. Lester Jr. (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 1053–1098). Charlotte, NC: Information Age Publishing and National Council of Teachers of Mathematics.

Yu-Ching, C. (2008). Elementary school EFL teachers' beliefs and practices of multiple assessments. *Reflections on English Language Teaching, 7*(1), 37–62.

Zan, R., & Di Martino, P. (2008). Attitude toward mathematics. In B. Sriraman (Ed.), *Beliefs and mathematics: Festschrift in honor of Guenter Toerner's 60th birthday* (pp. 197–214). Missoula, MT: Information Age Publishing.

Zollman, A., & Mason, E. (1992). The standards' beliefs instrument (SBI): Teachers' beliefs about the NCTM standards. *School Science and Mathematics, 92*(7), 359–364.