Chapter 22
What Do High School Teachers Mean by Saying "I Pose My Own Problems"?

Michal Klinshtern, Boris Koichu, and Avi Berman

Abstract The aim of this chapter was to identify mathematics teachers' conceptions of the notion of "problem posing." The data were collected from a web-based survey, from about 150 high school mathematics teachers, followed by eight semi-structured interviews. An unexpected finding shows that more than 50% of the teachers see themselves as problem posers for their teaching. This finding is not in line with the literature, which gives the impression that not many mathematics teachers are active problem posers. In addition, we identified four types of teachers' conceptions for "problem posing." We found that the teachers tended to explain what problem posing meant to them in ways that would embrace their own practices. Our findings imply that most of the mathematics teachers are result-oriented—as opposed to being process-oriented—when they talk about problem posing. Moreover, many teachers who pose problems doubt the ability of their students to do so and consider problem-posing tasks inappropriate for their classrooms.

Contents

M. Klinshtern (✉) • B. Koichu • A. Berman
Department of Education in Science and Technology,
Technion—Israel Institute of Technology, Haifa, Israel
e-mail: mklinst@tx.technion.ac.il; bkoichu@technion.ac.il; berman@technion.ac.il

F.M. Singer et al. (eds.), *Mathematical Problem Posing*,
Research in Mathematics Education, DOI 10.1007/978-1-4614-6258-3_22

Introduction

Mathematical problem posing is widely recognized as one of the central activities in mathematics and as a useful tool in the teaching and learning mathematics (e.g., National Council of Teachers of Mathematics [NCTM], 2000). However, a glimpse at the professional literature reveals that the notion of "problem posing" is used with a variety of not-always-compatible meanings and is applied to a variety of not-always-comparable teaching/learning situations. In addition, existing conceptualizations of problem posing, as diverse as they are, reflect the researchers' and mathematics educators' points of view on what counts (or not counts) as a worthwhile result of problem posing. The question of what problem posing means for mathematics teachers is still unexplored. The study presented in this chapter aims at partially closing this gap by exploring what the notion of "problem posing" and the associated notion of "my own problem" mean for in-service mathematics teachers.[1]

Theoretical Background

Problem posing as a teaching/learning tool has been extensively studied with students (e.g., Brown & Walters, 1983; English, 1997a, 1997b, 2003; Lowrie, 2004; Mestre, 2002; Silver, 1994) and with preservice and in-service teachers (e.g., Crespo, 2003; Koichu, Harel, & Manaster, 2013; Lavy & Bershadsky, 2003; Silver, Mamona-Downs, Leung, & Kenney, 1996). In this section we review how problem posing has been conceptualized in the aforementioned studies, with particular attention to studies in which teachers act as problem posers.

[1] This study is part of a Ph.D. dissertation, in progress, by the first-named author under the supervision of the two other authors. A brief version of this paper was accepted as a research report at PME-37.

Conceptualization of Problem Posing

Kilpatrick (1987) conceptualized problem posing as reformulating an existing problem in order to make it your own. This conceptualization is deliberately poser-centered and depends on one's decisions about whether an existing problem is modified enough to be perceived by the poser as his or her "own." From this perspective, one may decide that the problem is his or her own after making only a cosmetic change, whereas another person may feel that even the changes that look essential to the readers or solvers of the modified problem are not enough in order to claim that a "new" problem has been born.

Stoyanova and Ellerton (1996) considered situations in which students pose problems and defined problem posing as "the process by which, on the basis of mathematical experience, students construct personal interpretations of concrete situations and formulate them as meaningful mathematical problems" (p. 518). The subjective nature of this definition—one should decide in which meaning the problem is meaningful and for whom—is apparent (see Koichu & Kontorovich, 2013, for an elaborated discussion about this issue).

Silver (1994) referred to problem posing either as generating new problems and questions for exploring a given situation or reformulating a given problem during the process of solving it. This conceptualization leaves room to inquire in which sense the processes involved in generating new problems and reformulating the given ones could be seen as instantiations of the same process tagged "problem posing." The same question can be asked in relation to the highly inclusive definition of problem posing by Crespo (2003), who referred to *selecting* worthwhile problems and *designing* challenging tasks for teaching as particular cases of problem posing.

Teachers as Problem Posers

Crespo's conceptualization brings us to the question of whether there is room (and need) for using "self-made problems" in teaching, given that rich collections of expert-made problems are readily available, for instance, in mathematics textbooks. Extensive research on problem posing by mathematics teachers has not provided an unequivocal answer to this seemingly simple question. Indeed, in the majority of studies, mathematics teachers pose problems "on request" in laboratory conditions (e.g., Koichu et al., 2013; Silver et al., 1996) or pose problems in the framework of professional developmental workshops aimed at enhancing their problem-posing skills (e.g., Crespo, 2003; Lavy & Shriki, 2007). Moreover, probably the most frequently reported finding on problem posing by mathematics teachers is that not many teachers have skills to pose worthwhile problems (e.g., Singer & Voica, 2013).

A promising finding on mathematics teachers' willingness to modify textbook problems and create their own problems was reported in Nicol and Crespo (2006).

These scholars found that two participants in their study attempted to extend the mathematical content of the chosen textbook problems in order to make them more complex. When the teachers were asked to prepare collections of problems for teaching in fourth grade based on the available textbooks, they preferred to create some of their own. Based on these results, Nicol and Crespo distinguished between three ways of using textbooks by the teachers: “adhering” (i.e., do not see self as a resource), “elaborating” (i.e., seeing self as a resource), and “creating” (i.e., seeing self as a knowledgeable resource for designing problems). The latter way of using the textbooks “brought forth opportunities to consider connections within and beyond mathematical topics” (p. 347). Note that this study was conducted with only four preservice elementary school teachers.

Research Questions

To our knowledge, evidence about whether and how in-service high school mathematics teachers pose problems for real use in their classrooms does not yet exist. Accordingly, and in light of the reviewed literature, our study pursues the following interrelated research questions:

1. To what extent do high school mathematics teachers see themselves as posers of problems for their teaching? For what purposes do they pose problems?
2. How do the teachers perceive the notions “problem posing” and “my own problem”?

Methodology

The data were collected from a web-based survey, which was filled in by 151 mathematics teachers. In addition, a semi-structured interview was carried out with eight of the survey participants. The collected data also included two classroom observations and problems that some of the teachers sent us by email. Details of the survey and participants will be provided in the next section.

Survey and Participants

The SurveyMonkey tool[2] was used in order to administer an online survey. The survey consisted of an introduction, six background questions, and four questions about teaching practices (see Appendix). The goal of the background questions was to collect data on the participants’ teaching experience and academic education. The

[2] See http://www.surveymonkey.com.

goal of the questions on teaching practices was to collect data on how the teachers select mathematical problems for their teaching. The central question of the survey (Question 4) was: “*To what extent do you use the following resources for selecting mathematical problems for your teaching*?” The teachers were offered nine resources, one of which was “Pose my own problems.” The other resources were: “Textbooks,” “Other books,” “Internet resources,” “My prior academic study,” “Professional development workshops (PDW),” “Fellow teachers,” “Problems posed by my students,” and “Other sources.” For each resource, the participants were asked to choose one of the following five options: “Almost never,” “Rarely,” “Sometimes,” “Often,” and “Almost Always.” The central question of the survey was formulated in this way (i.e., problem posing was put in line with the other possible sources of problems for teaching) in order to avoid a situation in which the teachers would overestimate the role of problem posing in their practice by trying to guess the “correct” answer to the question.

Methodological advice presented in “Response Rates and Surveying Techniques” (SurveyMonkey, 2009) and in Cook, Heath, and Thompson (2000) was followed when validating and administering the survey. First, the formulations included in the survey were validated by five experts in mathematics education. Then, the survey was trialed with 20 high school mathematics teachers. Next, individually named e-mails with the invitation to respond to the survey were sent to about 500 secondary school mathematics teachers whose names appeared in the departmental database of mathematics teachers. These letters contained a brief outline of the study and a request to fill in the survey. Some of the respondents informed us that they sent the survey to their colleagues. One hundred and fifty one teachers responded to the survey during 2011–2012 school year. That is, we achieved a response rate of about 30%, which is compatible with the result of Cook et al. (2000), who found in their meta-analysis of response rates that the mean response rate for electronic surveys is about 34%.

From the responses to the background questions of the survey, we know that more than 80% of the respondents teach in high school (grades 10–12); 76% teach the advanced versions of the Israeli mathematics curriculum; and 82% of the teachers had teaching experience of ten or more years. Thus, the research sample represents well a cluster of experienced in-service mathematics high school teachers in Israel.

Interviews

Eight participants representing the groups of teachers who indicated that they pose their own problems “Rarely,” “Sometimes,” “Often,” and “Almost always” (two teachers per group) took part in the individual in-depth, semi-structured interviews. These teachers were chosen because they showed interest in the study, that is, they provided us with their contact information (see Appendix, Question 10), positively answered Question 11 of the survey and agreed to continue their participation in the study. Seven of the teachers had taught for more than 20 years and one teacher for more than 5 years. Thus, the interviewees represent well the participants of the survey in terms of their experience.

Three interviews were face-to-face, and the others were carried out by phone in order to get wide geographical access (Opdenakker, 2006). According to Opdenakker (2006), despite the absence of some social cues in phone interviews (e.g., body language) there are still enough social cues that can be used as valuable information (e.g., words, voice, and intonation). The interviews lasted between 20 and 60 minutes and were recorded, transcribed, and inductively analyzed (in the meaning specified, for instance, in Thomas, 2006).

During the interviews, teachers were asked to describe how they planned their lessons and selected mathematics problems for teaching. They were also asked to provide examples of their "own problems" and explain what "problem posing" means for them. Only two teachers gave an example of their own problems during the interviews. Two other teachers sent their problems by email after the interview. All other interviewees invited the interviewer to visit their classes.

Observations, a Lecture, and Teachers' Examples

As a result of the teachers' invitations to visit their classes, observations in two different classes of one of the teachers were carried out. This teacher was chosen because she indicated in the questionnaire that she poses her own problems "Often." In addition, this teacher gave a lecture about her problem-posing practices in a course for preservice mathematics teachers. The lecture was videotaped and served as a complementary data source.

Findings

The findings have been organized in accordance with the research questions. First, we report the extent to which the teachers saw themselves as posers of problems for their teaching and the purposes for which they posed their own problems. We then devote a section to the question of how the teachers perceived the notions "problem posing" and "my own problem." In the final section, we present an interesting result concerning the teachers' opinions about problem posing as a learning activity for their students.

Mathematics Teachers as Problem Posers

The percentages of using the different resources for choosing problems for teaching (see Appendix, Question 4) are presented in Table 22.1.

Table 22.1
Percentage of Responses to Problems Resources

	Problem resource	Almost never (%)	Rarely (%)	Sometimes (%)	Often (%)	Almost always (%)	No. of responses (100%)
1	Textbooks	1.3	0	2.6	23.8	72.2	151
2	Other books	10.1	9.4	26.8	39.6	14.1	149
3	Internet resources	14.4	17.8	37.0	19.9	11.0	146
4	Teacher PDW	18.1	24.2	38.9	11.4	7.4	149
5	Fellow teachers	12.2	18.9	36.5	25.7	6.8	148
6	My academic study	30.6	26.4	27.1	10.4	5.6	144
7	Pose my own problems	19.9	22.6	29.5	21.2	6.8	146
8	Problem posed by my students	51.7	27.9	16.3	3.4	0.7	147
9	Other	56.3	6.3	14.6	14.6	8.3	48

In view of past studies about teachers' usage of textbooks (e.g., Ball & Cohen, 1996; Ball & Feiman-Nemser, 1988; Ben-Peretz, 1990), it is not surprising that curriculum-based textbooks are the most frequently mentioned by the participants as a source of mathematical problems (see Table 22.1 and Figure 22.1). However, in light of the literature about teachers' difficulties with problem posing (e.g., Koichu et al., 2013; Silver et al., 1996; Singer & Voica, 2013), we were surprised to find that about 57% of the teachers indicated that they pose their own problems at least "sometimes," and 7% (11 of 146) "Almost always." The graph presented in Figure 22.1 summarizes the frequencies of using each resource at least "sometimes."

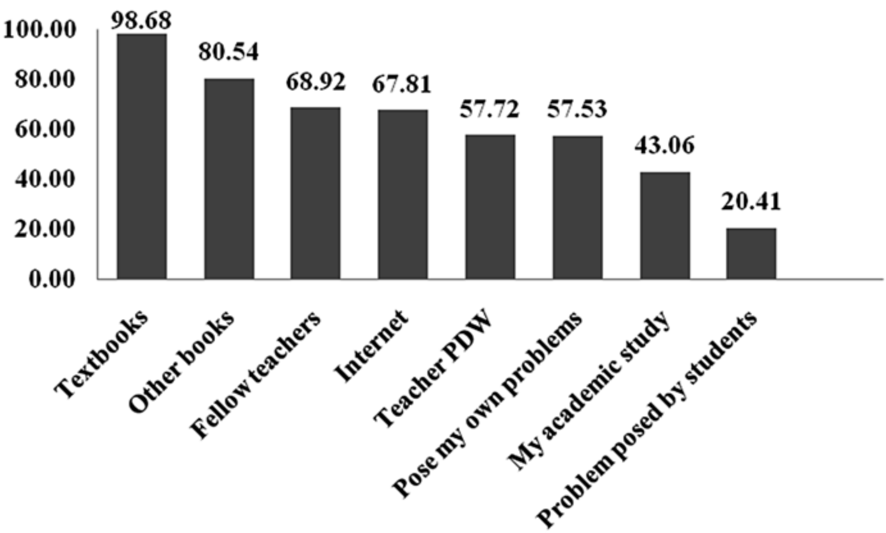

Figure 22.1 Frequencies of teachers' use of different problem resources.

The frequencies presented in Figure 22.1 can imply that the teachers tended to use the most available resources and turn to less readily available resources or to posing their own problems when they could not easily find problems that fitted their teaching needs. Indeed, the most popular problem resources appeared to be "Textbooks" and "Other books," which were most readily available. One may comment that the internet is the most available resource, given that in Israel all the teachers, as a rule, are proficient users of internet resources. However, it should be taken into account that using the problems found on internet resources requires preparing and printing work sheets, and it may not be the most parsimonious strategy. This may explain why the internet was only the fourth most popular resource, after "Textbooks," "Other books," and "Fellow teachers."

The survey included a request to explain when and why the teachers posed their own problems (see Appendix, Question 6). One hundred and nine out of 146 teachers (about 75%) responded to this request. Two main groups of reasons for problem posing were found: "In order to adapt a problem to my students' needs" (hereafter, *adaptations*) and "to interest myself" (hereafter, *self-interest*). The categories and subcategories of the reasons are presented in Figure 22.2. The distribution of the subcategories for the *adaptations* category is presented in Figure 22.3. In addition, three categories presented in Figure 22.3 unpack the category "others" from Figure 22.2. The most popular reason for posing problems, as reflected in Figure 22.3, is "for tests." A typical explanation for posing problems for tests was: "… because you don't want to be in a situation in which they [the students] saw the problem before …".[3]

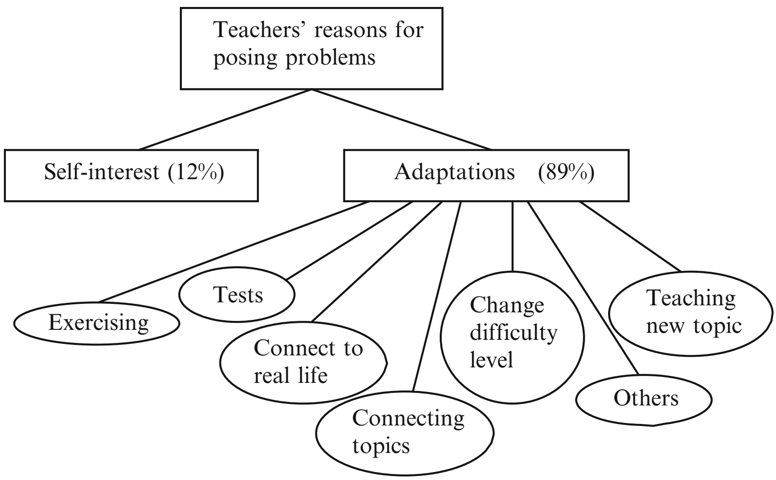

Figure 22.2 Teachers' reasons for posing problems.

Another finding that can be derived from Figure 22.3 is that about 27% of the teachers felt that they had to change the difficulty level of textbook problems in order to adapt them to their students' level. Some teachers claimed that textbook

[3] The quotations have been translated from Hebrew by the authors.

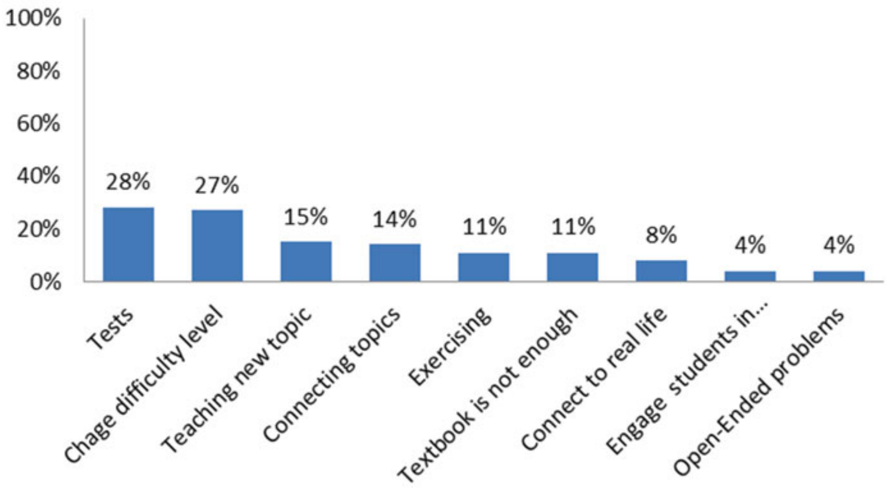

Figure 22.3 Teachers' reasons for posing problems in the *adaptations* category.

problems were too easy (e.g., "[I pose problems] when I feel that the level in the textbook problems was too low"), whereas others said that they needed to simplify textbook problems (e.g., "When the problem is not structured enough and there is a need to simplify it").

Rarely mentioned reasons, indicated by only one or two teachers (and thus not in Figure 22.3), were: "for reflecting the class work," "for integrating the education for values," "for inquiry by students," and "for didactical games."

Perceptions of the Notion of Problem-Posing

The teachers' perceptions were inductively distilled from the eight interviewees' explanations of what "posing a mathematical problem" meant to them, from examples of problems that they supplied as their own, and from their responses to the interview questions. Two main categories were defined; each category includes two subcategories. The names of the categories were given by us, the authors of the paper, based on the teachers' examples and explanations (Table 22.2).

Routine problem posing. Generally speaking, this category refers to textbook-like problems posed by the teachers for a test or in order to adapt a textbook problem to the students' needs.

Cosmetic change. For example, Teacher B posed for a test the following problem: "Sketch a graph of the function $y = \frac{(x-2)(x+3)}{(x+4)(x-5)}$ without formally exploring it."

Table 22.2
Categories of the Meaning of the Notion "Problem Posing" for the Teachers

Category		Description
Routine problem posing	Cosmetic changes	Changing an existing problem by replacing some of its parameters or its story without changing the idea of the solution
	In-the-moment problems	Unplanned using a known mathematical problem or spontaneously generated questions and examples during the lesson
Innovative problem posing	Combining ideas	Creating a new problem that, as a rule, requires for its solving the use of ideas or techniques that have been previously studied and used separately
	Using the same problem in different contexts	Using the same, probably known, problem when teaching different topics in order to encourage the students to solve it by using different tools, or as a starting point for explaining a new concept

During the lessons preceding the test, the students of Teacher B discussed problems of the same formulation, but with other functions. The above function was "invented" by Teacher B.

In the moment problems. All of the interviewees indicated that, during lessons, they deal with students' misunderstandings and obstacles by means of generating or recalling mathematical questions, problems or examples on the spot, without planning to do so prior to the lesson. About 5% of the teachers, who explained in the survey their reasons for posing their own problems, mentioned that it was done during the lessons, or in the moment. Interestingly, the interviewees could not provide examples related to this category during the interview. Some of them explained that this was because the questions looked too uninteresting out of the context of the lessons.

An example, however, was found, in a lesson in which Teacher N introduced the notion of functions to students. During this lesson, Teacher N realized that the concept of a linear function was not clear to her low-level ninth-grade students and decided to tell a story (see Figure 22.4).

> Suppose you did a math test and I decided to give a 4 point bonus to all students' final grades. What will be your grade now if you had 82? 95? 74? …
> Can you build a rule describing your new grade after the bonus?

Figure 22.4 An example of a problem posed during the lesson.

After the lesson Teacher N was asked if she planned this problem. She said: "I *invented* it during the lesson."

Seven of the eight interviewees, who had teaching experience of more than 20 years, indicated that their knowledge and experience enabled them to pose *in the moment problems*. Two teachers referred to this practice as problem posing from the beginning, and the others were unsure whether this practice could be called such. Two teachers started by saying that they did not pose many problems, but then they decided, probably due to the context of the interview, that recalling or formulating examples, routine problems, and questions during the lessons could be considered as problem posing (e.g., “Mostly, I don’t bring examples from a book. I invent them … Then the students say: it is not from the book, it’s B’s [problem]. So it is like I pose it, if it can be considered as problem posing. I have never thought of this … Naturally, I pose examples”). It looked like the teachers wanted to figure out how their perceptions could go along with the scholars’ definitions, and if they could consider themselves as problem posers.

Innovative problem posing. This category fits more readily the conceptualizations of problem posing as described in the literature. The main reasons for problem posing underlying the problems in the “*Combining ideas*” and “*Using the same problem in different contexts*” categories was the need to connect different mathematical topics.

The teachers’ need for a “feeling of innovation” (Kontorovich & Koichu, 2012) manifested itself in the 12% of the survey participants who wrote that they pose problems for their self-interest. Indeed, among the teachers’ explanations of the reasons for which they posed their own problems, we found the following examples: “It [posing problems] gives me an opportunity to use my creativity,” or, “The main reason [for posing problems] is to do something non-routine for me,” or “I enjoy it [problem posing], otherwise I would be bored.”

Combining ideas. About 14% of the teachers who responded to Question 6 of the survey (see Appendix) mentioned “Combining ideas for connecting topics” as a reason for posing their own problems. The teachers indicated that they need problems combining several ideas for tests, exams, and lessons aimed at summarizing particular topics. For example, Teacher R and her colleagues combined the previously taught ideas related to arithmetic and geometric sequences in the problem for the test presented in Figure 22.5.

Given an arithmetic sequence containing $2n+1$ elements. The first element of this sequence is equal to k, and the sequence difference is equal to d. From the given sequence, a new sequence was built as follows: The even elements were doubled, and the odd elements were increased by 4.

a) Using k and d, write the five first elements of the new sequence.
b) Prove that the odd elements of the new sequence form an arithmetic sequence.
c) Prove that the sum of the new sequence is $3n^2d + 3kn + nd + k + 4n + 4$
d) The second element in the new sequence is 7 times bigger than the first element in the original sequence. The elements in places 1, 6, and 97 in the new sequence form a geometric sequence. Find k and d if it is given that the elements in the sequence are integers.

Figure 22.5 An example of problem invention.

Another example was provided by Teacher M, who posed a problem for teaching a new subject: "One year I posed a problem about a magician that pulls scarves from a hat with or without returning. We defined when the magic succeeded and then you can ask many questions. In my opinion, it is better [than the problems] from the book because in the textbooks there are headlines and they [the students] don't see connections." This assertion is reminiscent of the comment by Ball and Feiman-Nemser (1988), who noted that in textbooks "problem solving is often trivialized and math portrayed as a collection of algorithms to be followed" (p. 402).

The need for posing problems with the potential to combine ideas and connect topics also manifested in the survey. Nine out of 24 teachers who selected "Other resource" for mathematical problems indicated that they used problems from past years' exams. The exams in Israel frequently include problems connecting ideas and topics.

It is interesting that two teachers mentioned, in their interviews, the difficulties students faced with problems that connected different ideas and topics. In the words of Teacher M, "There was a year that I posed problems on many occasions. I stopped doing so when I realized that the students did not enjoy them. Now, I do only small changes in existing problems and sometimes add challenging items [to the existing problems]." Teacher A described in the interview a situation in which "one student said [after the test] that it [the test] was too difficult, and when we [the students] solve textbook problems, they are different, they are simpler." These two comments suggest that the teachers' sensitivity to the students' needs may either encourage or discourage them from posing innovative problems.

Using the same problem in different contexts. The first example of a problem from this category is taken from the interview with Teacher M. She used a problem about finding the area of a triangle given the coordinates of its vertices when teaching plane geometry, vectors, and complex numbers. She mentioned the repeated use of the same problem when asked to provide examples of the problems she posed. An additional example came from Teacher N. She told us, as an example of a posed problem, that at the beginning of the topic "Functions" she reminds the students of one of the problems on sequences, and just changes the notation from *an* to $f(n)$.

Miscellaneous: The Teachers' Views of Their Students as Problem Posers

An interesting result is related to the extent to which the teachers used their own problems in class, as compared to the extent of using problems posed by their students. The result was derived from juxtaposing the responses to Questions 4 and 5 of the survey and from the interviews. In the graphs presented in Figure 22.6 we can see that there is a strong connection between the frequency of posing problems and the frequency of using them in class (based on Questions 4 and 5 of the survey). The x-axis is the frequency of posing problems, according to Question 4 ("To what

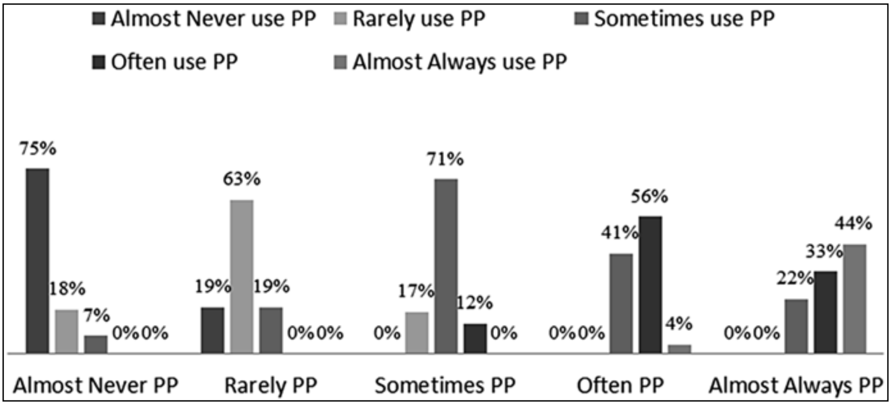

Figure 22.6 Using teachers' own problems for teaching.

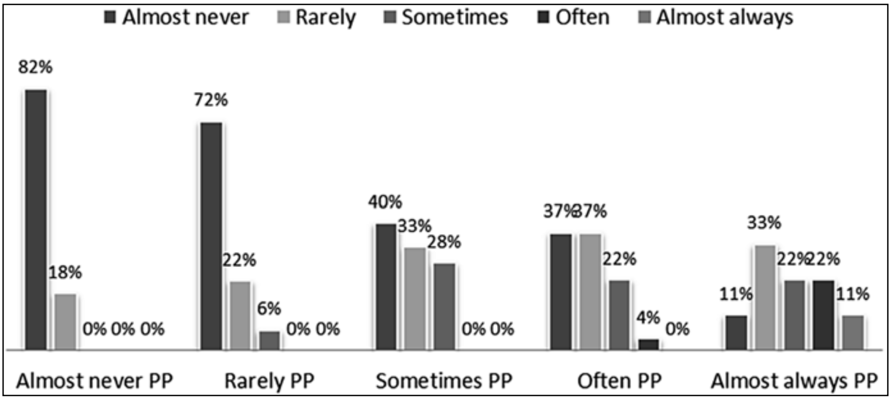

Figure 22.7 Using problems composed by students.

extent do you use your own problems as a resource for problems?"), and the bars indicate the frequency of using the posed problems in class.

It is reasonable to suggest that the teachers who posed problems tended to use them in their classes, and indeed Figure 22.6 shows that about 75% of the teachers who "sometimes" posed their own problems, "sometimes" use them. To us, it was reasonable to expect that the teachers who posed their own problems would encourage their students to pose problems. However, our results show that the teachers seldom used problems posed by their students. Figure 22.7 shows that only 28% of the teachers who posed problems "sometimes" tended to use their students' problems.

The interviews revealed that some teachers thought that their students were incapable of composing "good" problems. Teacher A said, for example: "I don't think that the students are capable of doing so [posing problems], they are still not mature enough so they don't have patience to sit and think about problems. So I don't want to waste time for this [problem posing activities]." With respect to the teacher's perception of problem posing, this assertion implies that, although teachers may appreciate the results of problem posing, this does not mean that they appreciate the learning potential inherent in the problem-posing process which is strongly emphasized in the professional literature.

Discussion and Conclusions

Both past and recent studies (e.g., Koichu et al., 2013; Silver et al., 1996; Singer & Voica, 2013) give the impression that not many mathematics teachers are active problem posers. In light of this, it is quite surprising that more than half of the participants in our survey indicated that they posed problems at least "Sometimes" and about 28% at least "Often." This supports Nicol and Crespo's (2006) finding that teachers can choose problems for their teaching either by elaborating or by creating (cf. Leikin & Grossman, 2013, for an example of how the teacher can creatively modify problems from geometry textbooks).

Our study also resulted in categorization of what problem posing means for the teachers. Two main categories were defined—"*routine problem posing*," and "*innovative problem posing*." The first category ("*routine problem posing*") consists of "*cosmetic changes*" to existing problems and "*in-the-moment problems*." The emergence of "*cosmetic changes*" and "*in-the-moment questions*" categories in our data supports Silver et al.'s (1996) observation that teachers tend to pose textbook-like problems and can also do so spontaneously during the lessons. In addition, the "*cosmetic changes*" category of problem posing is reminiscent of what Singer and Voica (2013) called "not interesting, being just scholastic" problems, and what Crespo (2003) called "non-problematic" or "avoiding pupils' errors" problems. However, our data suggest that problems created by "*cosmetic changes*" do not bear a negative connotation from the teachers' perspective. This is because this type of problem is instrumental in everyday teaching, especially for preparing tests and exams. This is in line with the comment by Prestage and Perks (2007), who claimed that teachers have to be able to make "in-the-moment shifts in a task in relation to learners' needs" (p. 382). Interestingly, the teachers in our study regarded this type of problem posing as belonging to their craft knowledge (in the words of one of the interviewees, "it is something that you do naturally") and connect it to their teaching experience.

The second category (“*innovative problem posing*”) consists of “*combining ideas*” and “*using problems in different contexts*.” These teachers’ perceptions of problem posing are in line with conceptualizations of problem posing by Kilpatrick (1987) and Silver (1994) (see section “Introduction”), as well as with the findings of Nicol and Crespo (2006), who mentioned that teachers can pose problems in order to connect different topics.

The presented findings imply that most of the mathematics teachers are result-oriented—as opposed to being process-oriented—when they talk about problem posing. That is, they give high value to problem posing when it leads to creating worthwhile problems for real use, and less value when it is an activity with the potential to develop their or their students’ mathematical skills (cf. Silver, 1997, for the analysis of how problem posing can foster mathematical creativity). This suggestion is indirectly supported by the fact that most of the participants in our study indicated that they rarely used problems posed by their students in teaching, and as a rule, did not ask their students to pose problems.

The identified conceptions suggest that there can be some discrepancy between how mathematics teachers treat the role of problem posing in their practice and how problem posing is treated in the research literature, especially in studies where the teachers pose problems “on request.” This merits further research attention, and probably, revisiting some of the ways by which the quality of the problems posed by teachers is evaluated in the frameworks of various studies on problem posing conducted in laboratory conditions. Specifically, we believe that the role of relevance of the posed problems to the teachers’ needs should be given attention and merit in future studies. With regard to teacher education it seems that understanding what experienced teachers mean by posing problems will be useful in training preservice teachers to use their own problems in their teaching practice.

In summary, we offer a general conceptualization of what problem posing seems to mean for the participants in our study: problem posing means an accomplishment that consists of *constructing a problem that satisfies the following three conditions*: (a) *it somehow differs from the problems that appear in the resources available to the teacher*; (b) *it has not been approached by the students*; *and* (c) *it can be used in order to fulfill teaching needs that otherwise could be difficult to fulfill*. Of course more comprehensive research is needed in order to understand whether this definition can be applied widely.

Appendix

The Survey

Selecting Problems to Be Used in Mathematics Teaching

This questionnaire is part of a research done in the Department of Education in Technology and Science at the Technion. The research aims at understanding how mathematics teachers select problems for their teaching. None of the questions has a "right" or "wrong" answer. It is very important that you will answer all the questions of this brief questionnaire.

We would like to thank you for the time you dedicated to answer this questionnaire.

1. The last three years I teach grades:

7	8	9	10	11	12

2. Usually I teach class levels

Strong	Medium	Weak

3. Describe all your special teaching project if any ___________________________

4. To what extent do you use the following resources for selecting mathematical problems for your teaching?

	Almost always	Often	Sometimes	Rarely	Almost never
Textbooks					
Other books					
Internet resources					
Professional development workshops					
Fellow teachers					
My prior academic study					
Pose my own problems					
Problem posed by students					
Others					

Point out any other resources that you use ___________________________________

5. To what extent do the following situations occur in your teaching?

	Almost always	Often	Sometimes	Rarely	Almost never
Use my own problems					
Activate students in problem posing					
Promote class discussion					
Encourage group work					

6. For what purposes do you pose your own problems?

___

7. Seniority in mathematics teaching

1–2 years	3–5 years	6–10 years	More than 10 years

8. To what extent the following situations are in your responsibility:

	Little	Much
Planning the school year		
Planning the lessons		
Execute my planning		
Select the mathematical problems to be used		

9. Education

	Math	Math Ed.	Science Ed.	Computer science	Engineering	Biology	Physics	Others
B.A./ B.Sc.								
M.A./ M.Sc.								
Ph.D.								
Other								

10. Personal details (optional)

Name: ________________
Email: ________________
Phone: ________________

11. I am interested in receiving updates about the results of the study

Yes	No

References

Ball, D. L., & Cohen, D. K. (1996). Reform by the book: What is—or might be—The role of curriculum materials in teacher learning and instructional reform? *Educational Researcher, 25*(9), 6–8, 14.

Ball, D. L., & Feiman-Nemser, S. (1988). Using textbooks and teachers' guides: A dilemma for beginning teachers and teacher educators. *Curriculum Inquiry, 18*(4), 401–423.

Ben-Peretz, M. (1990). *The teacher-curriculum encounter: Freeing teachers from the tyranny of texts*. Albany, NY: SUNY.

Brown, S., & Walters, M. (1983). *The art of problem posing*. Hillsdale, NJ: Lawrence Erlbaum.

Cook, C., Heath, F., & Thompson, R. L. (2000). A meta-analysis of response rates in web- or internet-based surveys. *Educational and Psychological Measurement, 60*(6), 821–836.

Crespo, S. (2003). Learning to pose mathematical problems: Exploring changes in preservice teachers' practices. *Educational Studies in Mathematics, 52*(3), 243–270.

English, L. D. (1997a). The development of fifth-grade children's problem posing abilities. *Educational Studies in Mathematics, 34*(3), 183–217.

English, L. D. (1997b). Promoting a problem posing classroom. *Teaching Children Mathematics, 4*(3), 172–179.

English, L. D. (2003). Engaging students in problem posing in an inquiry-oriented mathematics classroom. In F. Lester & R. Charles (Eds.), *Teaching mathematics through problem solving* (pp. 187–198). Reston, VA: National Council of Teachers of Mathematics.

Kilpatrick, J. (1987). Problem formulating: Where do good problems come from? In A. H. Schoenfeld (Ed.), *Cognitive science and mathematics education* (pp. 123–147). Hillsdale, NJ: Lawrence Erlbaum.

Koichu, B., Harel, G., & Manaster, A. (2013). Ways of thinking associated with mathematics teachers' problem posing in the context of division of fractions. *Instructional Science, 41*(4), 681–698. Retrieved May 31, 2013, from http://link.springer.com/article/10.1007/s11251-012-9254-1#page-1.

Koichu, B., & Kontorovich, I. (2013). Dissecting success stories on mathematical problem posing: A case of the Billiard Task. *Educational Studies in Mathematics, 83*(1), 71–86.

Kontorovich, I., & Koichu, B. (2012). Feeling of innovation in expert problem posing. *Nordic Studies in Mathematics Education, 17*(3–4), 199–212.

Lavy, I., & Bershadsky, I. (2003). Problem posing via "What if not?" strategy in solid geometry—A case study. *The Journal of Mathematical Behavior, 22*(4), 369–387.

Lavy, I., & Shriki, A. (2007). Problem posing as a means for developing mathematical knowledge of prospective teachers. In J. H. Woo, H. C. Lew, K. S. Park, & D. Y. Seo (Eds.), *Proceedings of the 31st Conference of the International Group for the Psychology of Mathematics Education* (Vol. 3, pp. 129–136). Seoul, Korea: PME.

Leikin, R., & Grossman, D. (2013). Teachers modify geometry problems: From proof to investigation. *Educational Studies in Mathematics, 82*(3), 515–531.

Lowrie, T. (2004). Designing a framework for problem posing: Young children generating open-ended tasks. *Contemporary Issues in Early Childhood, 3*(3), 354–364.

Mestre, P. J. (2002). Probing adults' conceptual understanding and transfer of learning via problem posing. *Journal of Applied Developmental Psychology, 23*(1), 9–50.

National Council of Teachers of Mathematics. (2000). *Principles and standards for teaching mathematics*. Reston, VA: Author.

Nicol, C. C., & Crespo, S. M. (2006). Learning to teach with mathematics textbooks: How preservice teachers interpret and use curriculum materials. *Educational Studies in Mathematics, 62*(3), 331–355.

Opdenakker, R. (2006). Advantages and disadvantages of four interview techniques in qualitative research. *Forum Qualitative Sozialforschung/Forum: Qualitative Social Research*, *7*(4), Art. 11.

Prestage, S., & Perks, P. (2007). Developing teacher knowledge using a tool for creating tasks for the classroom. *Journal of Mathematics Teacher Education, 10*(4), 381–390.

Silver, E. A. (1994). On mathematical problem posing. *For the Learning of Mathematics, 14*(1), 19–28.

Silver, E. A. (1997). Fostering creativity through instruction rich in mathematical problem solving and problem posing. *ZDM, 29*(3), 75–80.

Silver, E. A., Mamona-Downs, J., Leung, S. S., & Kenney, P. A. (1996). Posing mathematical problems: An exploratory study. *Journal for Research in Mathematics Education, 27*(3), 293–309.

Singer, F. M., & Voica, C. (2013). A problem-solving conceptual framework and its implications in designing problem-posing tasks. *Educational Studies in Mathematics, 83*(1), 9–26.

Stoyanova, E., & Ellerton, N. F. (1996). A framework for research into students' problem posing in school mathematics. In P. Clarkson (Ed.), *Technology in mathematics education* (pp. 518–525). Melbourne, Australia: Mathematics Education Research Group of Australasia.

SurveyMonkey (2009). *Response rates & surveying techniques—Tips to enhance survey respondent participation.* Retrieved May 2, 2010, from http://s3.amazonaws.com/SurveyMonkeyFiles/Response_Rates.pdf

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation, 27*(2), 237–246.