In-service Training in Alternative Assessment with Singapore Mathematics Teachers

Fan Lianghuo

National Institute of Education, Nanyang Technological University, Singapore

Abstract: *Fifty-nine primary mathematics teachers of three intakes participated in in-service training in alternative assessment newly offered at a university in Singapore. A study, action research in nature, was undertaken to examine the effects of the in-service training and investigate relevant issues in promoting teachers' use of alternative assessment in classrooms. Data were mainly collected through questionnaire surveys, the participants' work on an authentic alternative assessment task, and field-notes of the training. The results indicate that systematic training in alternative assessment is highly needed for school teachers, and in-service training can be an effective way to promote their professional growth in this area, especially through their integrating authentic alternative assessment tasks into their actual classroom teaching as part of the training. In addition, the study reveals that the current school curriculum does not well reflect the new development of assessment and therefore there is a need to integrate the concept and content of alternative assessment into school curriculum to facilitate teachers' use of alternative assessment in classroom. Some other relevant issues, including advantages and disadvantages of in-service training, are also documented in the article.* [1]

Introduction

Since the early 1980s, educational researchers and reformers have proposed and practiced a wide range of alternative methods in assessing students' learning to overcome the inadequacies of the traditional written-test-based assessment (e.g., see Adam, 1998; Berenson & Carter, 1995; Clarke, 1997; Raymond, 1994; Richardson, 1988; Stacy, 1987; Stempien & Borasi, 1985). In traditional written tests, the focuses are often on a static body of subject knowledge and students' memorization. Because of the nature of the traditional written test (e.g., students are strictly restricted in terms of when, for how long, and where to take the test), it is difficult

---

[1] A progress report of the research based on data from the first two intakes, entitled "Learning to integrate alternative assessment into mathematics instruction: The effects of in-service training", was published in post-conference proceedings, *Holistic review of the mathematics curriculum: What is next?* (Leung, 2001). This paper is a final report including new data that were not available for the earlier report.

for teachers to use them to effectively assess students' conceptual understanding, higher-order thinking skills, problem solving ability, and communication skills. In addition, students' affect in learning mathematics is ignored in such written-test-based assessment. The so-called alternative methods, such as assessment based on interview and classroom observation, oral presentation, performance tasks, portfolio, project work, and journal writing, have been increasingly accepted and used in educational practice to better reflect the new desired instructional goals and shifted values in education (e.g., see National Council of Teachers of Mathematics (NCTM), 1989; Singapore Ministry of Education, 2000).

As assessment is an essential part of the teaching and learning process in classrooms, teachers need to keep abreast of the new development in assessment and be equipped with necessary knowledge and skills for implementing new ways of doing assessment. For this purpose, an in-service training course on assessment, of which alternative assessment is a key component, has been recently introduced at the National Institute of Education, for primary school teachers as part of an in-service training package. Focusing on alternative assessment, the study, which in a sense is action research in nature, was undertaken to examine the effects of the program (course) and investigate relevant issues in supporting teachers' use of the new modes of assessment in their classroom instruction. The paper presented here describes the practice of the training and concludes the study.

The In-service Training

General Information

The in-service training on new developments in assessment has been offered to three intakes (groups) of classroom teachers. The first group, consisting of 29 teachers, participated in the training from February to April 2000, the second group, consisting of 18 teachers, received the training from June to August 2000, and the last group of 12 teachers attended the training program from June to September 2001. There were a few participants in each group who were unable to complete the program because of various reasons and are excluded from this report.

The overall course objectives were fourfold. At the end of the course, the participating teachers were expected to be able to (1) apply assessment theory to construct a valid mathematics test, (2) apply alternative methods to assess students in mathematics, (3) apply information technology in assessment in mathematics, and (4) evaluate mathematics program for low ability and high ability students.

The time duration for the training was 30 hours in 10 sessions. The participating teachers were required to attend eight regular sessions of lectures on the campus of the training institution, once a week, and use the other two sessions during the course to actually try out what they learned from the course in their own classroom settings.

Participants

The availability of the in-service training course was made known by the Ministry of Education (MOE) of Singapore to school teachers through its official channels as part of MOE's initiatives for teacher professional development. Teachers who were interested in the training then submitted their application to the Ministry through their schools, and only those who were finally approved by MOE were admitted into the training program.

In total, 59 teachers from 49 primary schools participated in the training. Those 49 schools represented a variety of types and qualities of primary schools in the country, from ordinary neighbourhood schools to nationally high-performing schools. Most participants were then teaching mathematics at upper primary school levels.

According to the available data collected from 49 teachers through questionnaire surveys (50 teachers answered the survey, but one did not provide the information), the average length of teaching experience of those teachers was 19.8 years with a range from 3 to 40 years. Furthermore, 77.6% had been in teaching service for more than 10 years, while only 3 teachers had less than 5 years of teaching experience. This fact largely reflects the necessity of in-service training for those teachers to improve their knowledge of the new development of assessment, especially alternative assessment.

The sample of the teachers in this study was not randomly selected. It seems reasonable to suggest that they represented better-than-average mathematics teachers in Singapore primary schools. In fact, the teachers approved by the MOE for the in-service training were generally believed to be good teachers, and are expected to play a leading role in teaching and/or in teacher professional development in their schools in the area they receive training. In particular, according to the questionnaire surveys, more than one third of the participants in this in-service training program were heads of departments or co-ordinators of grade levels. No significant differences were found among the three groups in terms of their highest educational levels and the lengths of teaching experiences.

Modes of Training

With respect to the training methods in the area of alternative assessment, there is slight difference between the training provided for the first two groups of the participants and that for the third group. The change was made as a result of a major progress review of the program that took place after the first two groups finished the training (see Fan, 2001). Nevertheless, below the descriptions about the method matters are generally applicable to all the groups, unless explicit distinction is noted for the three groups.

For the first two groups of the teachers, about one third of the total stipulated time for the program was devoted to the area of alternative assessment. For the third group, the amount of time was increased to 40% of the total time as the aforesaid progress review revealed that it is desirable to allocate some more time to this domain in the program.

For all the groups, the training program included three hours of course time for the participating teachers to review and reflect on what they learned about alternative assessment methods from the training and work on an authentic learning task for the course in their schools (also see more details below).

Regarding the content of the training, it started with an in-depth discussion of the concept of assessment and alternative assessment. The NCTM description, "assessment is the process of gathering evidence about a student's knowledge of, ability to use, and disposition toward mathematics and of making inference from the evidence for a variety of purposes" (NCTM, 1995, p.3), was adopted to define the new concept of assessment. The participants were led to reflect on the advantages and disadvantages of using traditional written test, and discuss why assessment should be an integral part of teachers' daily instruction and why alternative assessment is needed under the new concept of assessment and new educational context.

The main body of the training in alternative assessment for the first two groups of teachers, given time-limitations, focused on seven relatively well accepted and widely used methods of alternative assessment. The seven methods were performance/authentic-task-based assessment, project-based assessment, journal-based assessment, portfolio-based assessment, student-presentation-based assessment, classroom-observation-based assessment, and interview-based assessment. For the third group, student self-assessment as an alternative assessment was also included, as the first two groups of teachers expressed their interest in this method and that three hours more time was given for the third group in alternative assessment. Readers should note that, due to this fact, the data analysis below is not applicable to that particular method unless the data are specific to the third group of the participants. For each of those methods, the training covered consistently, among other aspects, (1) what the method is, (2) what its advantages and disadvantages are, and (3) how to use it in actual classroom teaching.

The instructional methods included typical regular lecturing, classroom discussions, group activities, questions and answers (face-to-face or through internet), and so on. Concrete examples of different ways of conducting alternative assessment were presented in a variety of forms including audio-records (e.g., for interview) during in-class sessions to facilitate the participants' understanding. All the participating

teachers were required to read a substantial amount of materials in their own time. The second and third groups were also given an additional list of references containing dozens of literature references in the area, but reading of them was optional.

A special arrangement for the training program was that "authentic assessment" was not only taught in the training course, but also practically used to assess the participants' learning. That is, the teachers were required, as a major assignment, to authentically integrate one alternative method they learned from the training program into their daily instruction using the classes they were then teaching. Below is a condensed version of the assignment for the third group of participants.

> *In this assignment, you are required to design one of the following four alternative assessment methods: a project-based assessment, a journal-based assessment, an interview-based assessment, or student self-assessment, and then use it to assess students you are currently teaching.*
>
> *Your submission should include the following components.*
> *(1) Explain what method you choose to design and implement, why you choose it, what are the purposes of your using the method to assess students.*
> *(2) Describe the method (too) itself. If it is project-based or journal-based, describe what the task is and how students should do it. If it is interview-based, describe the questions you will use for the interview. If it is student self-assessment, describe the task that students should do and what you want students to assess themselves.*
> *(3) Explain how you will assess or gather information from students' work on what you designed for them. If you think appropriate, you should establish a rubric to serve the purpose.*
> *(4) Report the results of your using the assessment tool with your students and present conclusions from your assessment.*

The assignments for the first two groups were basically the same as for the third group, except for the first group, the assignment included only the first three methods, and for the second group, the fourth option was oral presentation assessment instead of student self-assessment.

All the participating teachers were asked to complete all the requirements in the assignment within three to four weeks. In addition, the nature of the assignment as an "authentic learning task" was emphasized to all the participating teachers. It was also stressed that the assignment should be regarded as an integral part of their training.

Data Collection

A variety of instruments and resources were employed to gather data during this study. They included three formal questionnaire surveys, the teachers' work on the authentic learning task, field-notes taken during and after the course from classroom teaching activities, informal interviews, personal communications, and collaborations in this area between the trainer (this author) and the teachers after the training.

The three questionnaire surveys were administered in April 2000, July 2000, and September 2001 after the three groups respectively completed the training on alternative assessment in the regular sessions, using the same questionnaire constructed specifically for this study. In total, 50 out of the 59 teachers answered the questionnaire. Among them, 27 were from the first group, 16 from the second, and 7 from the third. The questionnaire contains items for background information of the respondents, as noted earlier. Two main items that were directly targeted on the purpose of the study, are shown below as item A and item B.

The participating teachers' work on the "authentic learning task", including both the process and the product of their work, is another key component of the original data for the study. This data became evidence of "authentic-task-based assessment in their learning of the alternative methods" and thus was an important component of the analysis of the effects of the training program.

The field-notes collected in the study included anecdotal and narrative records on regular lecturing, classroom discussions, informal interviews with the participants, personal communications through direct conversations, and e-mail both during and after the course. Such data are naturally more occasional and less systematic. However, they often contain more specific and detailed information about different aspects of the training and offer useful insight into various issues in the study. Finally, relevant follow-up collaborations between the researcher and some participating teachers after the training on using alternative assessment in classrooms were also noted.

Results and Discussions

As said earlier, the training program started with whole class discussion on the concept of assessment before the introduction of alternative assessment. It revealed that virtually all the teachers held typical traditional and narrow views about this issue: to the question "what is assessment?", the answer given was "test". No one put the topic in a broader perspective or displayed knowledge of alternative assessment. The result was at first quite surprising.

Item A. Before taking this module, did you hear of, know, and use the following methods of doing alternative assessment? Choose (circle) yes or no below.

Methods	Heard of the term?		Know its meaning?		Used the method?	
Performance tasks	Yes	No	Yes	No	Yes	No
Project	Yes	No	Yes	No	Yes	No
Journal	Yes	No	Yes	No	Yes	No
Classroom observation	Yes	No	Yes	No	Yes	No
Oral presentation	Yes	No	Yes	No	Yes	No
Interview	Yes	No	Yes	No	Yes	No
Portfolio	Yes	No	Yes	No	Yes	No
Student self-assessment*	Yes	No	Yes	No	Yes	No

Item B. After taking this module, how much are you confident of your knowledge of, ability, and willingness to use the following methods for alternative assessment? Please circle (Note: 4-very strong; 3-strong; 2-some; 1-not at all).

Methods	Knowledge of				Ability to use				Willingness to use			
Performance tasks	4	3	2	1	4	3	2	1	4	3	2	1
Project	4	3	2	1	4	3	2	1	4	3	2	1
Journal	4	3	2	1	4	3	2	1	4	3	2	1
Classroom observation	4	3	2	1	4	3	2	1	4	3	2	1
Oral presentation	4	3	2	1	4	3	2	1	4	3	2	1
Interview	4	3	2	1	4	3	2	1	4	3	2	1
Portfolio	4	3	2	1	4	3	2	1	4	3	2	1
Student self-assessment*	4	3	2	1	4	3	2	1	4	3	2	1

*Note: "Student self-assessment" was only included for the third group.

The informal interviews and conversations with some teachers after the class discussion, however, showed three possible reasons for the above result. First, most participants had been in the teaching profession for many years (actually the average was nearly 20 years; see above) and had been used to traditional ways of

teaching and assessing. Therefore, it is understandable that many had established a rather stable traditional mindset that is not easy to change unless external help or force is given. Second, those participants had little exposure to new ideas of assessment because of their working environment and heavy teaching responsibility. Although this fact is not to be further discussed here, it does suggest the importance of in-service training for school teachers especially for those who have been in service for a long time. Third, for some participants who had heard of the new ideas of assessment or occasionally used them in actual teaching, they largely treated the ideas as something extra and unrelated, and had not established a clear cognitive picture of the newer and broader concept of assessment.

The way the discussion was held, as described earlier, to introduce the new concept of assessment, proved to be effective. As the participants had much teaching experience, they showed no difficulty in reflecting and understanding the advantages and disadvantages of using traditional written test as a tool to do assessment under the new context of mathematics education. They also had no difficulty accepting the new concept of assessment based on the NCTM's definition. After they understood the new concept of assessment, it was quite natural for them to realize the necessity as well as the usefulness of utilizing alternative assessment methods for teaching and learning.

Based on the data collected from 50 teachers' responses to Item A in the questionnaire, Figure 1 depicts participants' background concerning seven alternative assessment methods, measured by three indicators - exposure (heard of the method), knowledge (know its meaning), and experience (used the methods). Regarding the student self-assessment method which was only included specifically in the third group, 4 (57%) out of the 7 respondents heard of the method, 6 (86%) knew its meaning, but no one (0%) actually used it in their teaching.
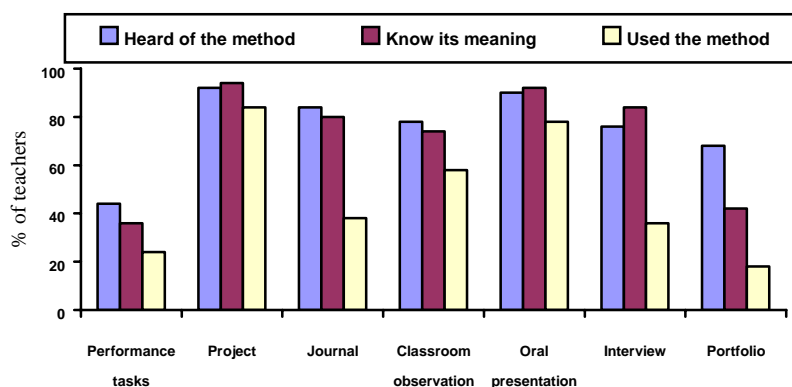

Figure 1. Participants' background in alternative assessment methods

The results based on the three indicators reveal that the two assessment tools that the participating teachers felt most familiar with prior to training were project and student oral presentation. This appears to be quite reasonable, because for the last several years Singapore school teachers in all the subjects have been strongly urged by the Ministry of Education to use project work in their teaching; and as to oral presentation, it is often used together with project work. That is, students are often asked to orally present the final product of their project work in class. In fact, oral presentation is sometimes simply taken as part of project work (e.g., see University of Chicago School Mathematics Project, 1995, p. xxiii), though it can also be used for non-project tasks.

On the other hand, there were still nearly 20% of the teachers who had not used project work and oral presentation in their classroom instruction. Furthermore, more than 40% of the teachers did not use classroom observation as a way of doing assessment, more than 60% did not use journal writing and interview methods, and around 80% did not use performance tasks and portfolios.

It can be also seen clearly from the figure that there were more teachers who had heard of or known the meaning of the alternative assessment methods than those who had actually used the methods in their previous teaching. In other words, some teachers did not use the methods they already heard of or knew before. The main reason, as revealed later through informal interviews and conversations, is that the teachers feel that their knowledge and understanding of these methods were not adequate enough so they lacked willingness as well as confidence to use them. Even for those who had actually used the methods, they had done so without clear awareness of the new concept of assessment.

From the above, it is clear that there is much need to provide systematic training for school teachers in the area of alternative assessment, and we believe that the training program discussed here was a timely offer for in-service teachers.

To see if there was a statistically significant difference in the background of the different groups of teachers, z test was conducted on the proportions of the responses from the first two groups for each alternative assessment method for each of the three indicators. No significant differences were found from the results with an alpha level of 0.05 (for detailed test results, see Fan, 2001). The results seem to be quite reasonable, as the time interval between the first two intakes was only about four months, and it was unlikely that school teachers would significantly change their professional background in this area in such a short time under the normal working environment. The statistical test was not applied to the third group, as the group size was too small (n = 7).

Item B in the questionnaire was constructed to examine the effects of the in-service training from the participants' perspective by reporting their own confidence level about their knowledge of the alternative assessment methods, as well as their ability and willingness to use those methods after taking the training course. Each of the three factors, knowledge, ability, and willingness, is considered to be important for teachers to implement the new modes of assessment in their own teaching. Table 1 presents the results obtained from the participants' responses.

Table 1.
Percentages of teachers who had confidence in their knowledge of, ability, and willingness to use alternative assessment methods after in-service training

	Indicator	Confidence level[a] (%)			
		4	**3**	**2**	**1**
Performance tasks	Knowledge	24	70	6	0
	Ability	16	68	16	0
	Willingness	30	58	10	2
Project	Knowledge	42	56	2	0
	Ability	32	60	8	0
	Willingness	42	52	6	0
Journal	Knowledge	30	66	4	0
	Ability	22	70	8	0
	Willingness	30	52	14	4
Classroom observation	Knowledge	40	52	8	0
	Ability to use	34	56	10	0
	Willingness	38	50	12	0
Oral presentation	Knowledge	40	60	0	0
	Ability to use	34	64	2	0
	Willingness	46	48	6	0
Interview	Knowledge	30	64	6	0
	Ability	22	68	10	0
	Willingness	20	64	16	0

Portfolio	Knowledge	22	66	12	0
	Ability	12	62	24	2
	Willingness	12	48	34	6
Student self-assessment[b]	Knowledge	14	86	0	0
	Ability	14	71	14	0
	Willingness	0	86	14	0

Note: $n = 50$, except for "Student self-assessment", where $n = 7$. [a]4-very strong, 3-strong, 2-some, 1-not at all. [b]The sum of the percentages in that row is not exactly 100% due to rounding.

The results in Table 1 reveal that the in-service training program had overall very positive effects on those teachers' knowledge, ability, and disposition concerning the new ways of conducting assessment, as an overwhelming majority of the participants had established strong or very strong confidence in all the three indicators. Particularly, more than 90% of the teachers reported that they had strong or very strong confidence in their knowledge of all the alternative methods introduced in the program, except for portfolio-based assessment, for which the percentage was 88%. In comparison, one can see that more teachers expressed strong or very strong confidence in their knowledge of each alternative method concerned than in their ability to use the method. This result is not surprising, as doing something is often more challenging than just knowing it.

On the other hand, Table 1 also shows that one teacher had no confidence at all in her own ability to use portfolio-based assessment. It was found later that the teacher was actually absent in the session that covered the topic, likely explaining the absence of the influence of the training on her in the topic. Similarly, the data on the third indicator of "confidence" suggest that one (2%), two (4%), and three (6%) teachers likely would have no willingness to use performance task, journal, and portfolio, respectively, as a tool to conduct assessment in their daily instruction. The two main reasons were identified based on the observation made during the training: one is that the teachers did not clearly understand the meaning of the method, and the other is that they felt the method was too difficult (e.g., too time consuming) to be implemented.

In addition, it is clear from Table 1 that the teachers made most progress in the method of using performance tasks, and least in portfolio assessment method, which is consistent with the nature of those two assessment methods (e.g., see Clarke, 1997; Van de Walle, 2001).

A chi-square test was conducted to see if the first two groups of the participants measured their achievements of knowledge (the first factor of analysis) differently in terms of the distribution of the responses across the four levels of confidence for each alternative assessment method covered during the training. The results, as reported in Table 2, showed no significant difference at the 0.05 level.

Table 2.
Chi-square test from the first two groups of teachers about their confidence in their knowledge of alternative assessment methods

| | Group | Confidence | | | | χ^2 | p |
		Very	Strong	Some	Not at all		
Performance tasks	1st	7	18	2	0	2.70	.260
	2nd	1	14	1	0		
Project	1st	12	14	1	0	2.50[a]	.286
	2nd	4	12	0	0		
Journal	1st	10	16	1	0	3.03[b]	.220
	2nd	2	13	1	0		
Classroom observation	1st	10	13	4	0	3.23	.199
	2nd	5	11	0	0		
Oral presentation	1st	11	16	0	0	1.26	.534
	2nd	5	11	0	0		
Interview	1st	8	16	3	0	1.93	.381
	2nd	5	11	0	0		
Portfolio	1st	6	16	5	0	1.52	.467
	2nd	3	12	1	0		

Note: $n_1 = 27$ (for the 1st group), $n_2 = 16$ (for the 2nd group), and $n = n_1 + n_2 = 43$ (for the total). For each Chi-square test, $df = 2$, as the last column ("not at all") was excluded with both observed frequencies for the two groups being zero. [a]Two expected frequencies are less than 1. [b]One expected frequency is less than 1.

Similarly, chi-square significant tests were also applied to the data on the other two factors, namely, ability and willingness. The results also showed no significant differences in the responses between the two groups (for detailed test results, see Fan, 2001). It implies that the effects of the in-service training program on the first two intakes of teachers were overall stable and consistent. This result can be easily interpreted as there being no significant changes in the basic aspects of the training program offered to the first and second intakes, including the modes of training and the participants' background. In this sense, the fact also implies that the data collected from the survey were reliable. The third group was excluded from the statistical test, as the sample size is too small. Nevertheless, judging from the trainees' assignments and other facts (including that they were given more time and the trainer had more experience), the effects seem to have no difference from the first two groups, if not better.

The data collected from the questionnaire surveys, as discussed above, provided an important measure of the effects of the in-service training, based on the participating teachers' own judgment. In contrast, their work on the major assignment provided concrete and direct evidence to look into the issue. The task required teachers to authentically use what they learned in the training in their actual classroom instruction. During and after the participants' work on the assignment, unstructured interviews and other forms of communication with some of the teachers were held with focus on the difficulties they encountered and the insights they gained from the assignments.

In general, the assignment was well accepted by teachers with part of the reason that the assessment was authentic. Teachers were fascinated with the concept of alternative assessment, and eager to try what they learned about the alternative assessment in the classrooms they were teaching. Moreover, a few teachers asked, and were allowed, to try alternative assessment methods other than those listed in the assignment, as they felt it could be even more authentic in terms of "integration" of the methods into their classroom instruction because of the mathematics topics they were then teaching. Also, a few teachers went beyond the requirement of the assignment. For example, one teacher tried a combination of performance tasks, student self-assessment and journal writing. Another tried both journal and structured interview.

Although there were totally 59 teachers participating in the training, one teacher did not finish the assignment due to an overseas trip, and another teacher's work was missing during the data recording. Therefore, data analyzed in this study were the results from the remaining 57 teachers' work. Among these teachers, 49% chose project as the tool in their assignment, 25% chose journals, 7% interview, 5% oral presentation, 4% performance tasks, 2% student self-assessment, and 9% two or

more tools from project, oral presentation, classroom observation, and student self-assessment.

The results of analyzing teachers' work reveal that the task was challenging. One teacher said in her work, "This assignment sounded easy enough in the beginning. All one had to do was to design an alternative assessment, implement it, and, … Well, that's where the problem starts! Our lecturer had given us concise explanations and examples of the different types of alternative assessments but when you set about using them in the classroom you are faced with a dilemma."

Difficulties were found at various stages, from designing the task, to implementing it, to evaluating students' work on the task, and to summarizing and writing the report. Two main reasons were identified. First, not only the teachers but also the students they were teaching had little, if any, experiences with alternative assessment. Therefore, both sides felt much uncertainty during the process. For example, teachers who chose journal writing were commonly asked by their students why they needed to do writing which they never did before and why their schoolmates in other classes did not need to do such work. Second, in general, implementing alternative assessment is more time-consuming than doing traditional written tests for both teachers and students. In fact, about 20% of the teachers explicitly pointed out this issue in their assignments. In-service teachers are normally very busy in their daily teaching, a main disadvantage for in-service training. This was particularly true for those participants, because most of them were senior teachers and many had other duties such as being heads of departments.

Designing the tool for the task proved to be most difficult. As the tool must fit the topics the teachers were then teaching, they were expected to create original ones, which appeared to be very challenging to many teachers. A few teachers were not able to do so and misused the traditional textbook problems as projects or performance tasks. Another difficulty reported by the teachers was how to evaluate students' work on the alternative assessment tasks. In particular, teachers had difficulty in establishing appropriate rubrics to evaluate students' work on projects and some other tasks. For instance, one teacher wrote in her write-up for the assignment, "It is not an easy task assessing the pupils as I lack exposure in this area. Much practice on my part is needed to refine my rubric." Moreover, a few teachers simply avoided using rubrics that were actually needed for the tasks they designed. Of the 28 teachers who used rubrics in their assignments, about half of them used general rubrics instead of task-specific ones which would be more appropriate though also more difficult, and nearly two thirds adopted holistic rubrics, not analytic ones (for a discussion on rubrics, see Kulm, 1994).

Despite the difficulties, the results of this authentic learning task were in general very encouraging. Most of the teachers integrated the task into their teaching very

creatively and successfully. According to the information collected from about 85% of the teachers through their assignments and informal interviews, all the teachers found alternative assessment helpful and practical, and they learned well in this new domain of assessment. Below are some examples of teachers' reflections in their report about the authentic learning task and about the alternative assessment tools they tried out in schools, which document clearly how those teachers made their efforts in and what they benefited from the task.

One teacher who tried group work and oral presentation said, "This oral presentation was greatly enjoyed by the pupils as it was their first experience of almost playing the role of a teacher in explaining their findings…. I definitely see the benefits of group interaction and alternative assessments as being an integral part of the different disciplines in the [MOE] curriculum."

Another teacher who selected journal writing wrote, "I feel that journal is a new experience to my pupils…. the pupils will gradually be able to do this kind of an activity with more exposure…. I will not give up but will try to make my students communicate their ideas and feeling about math topics."

Still, another teacher who used performance task and student self-assessment reflected, "The tools used in alternative assessment are useful as it allows pupils a chance to vocalize their thoughts and show what they could really do…. though the holistic or analytic marking with the rubric can be quite subjective and may prove difficult for teachers. My pupils and I have thoroughly enjoyed the activity. They are now more motivated to set their targets for maths and as for me, I have learnt more about their mathematical capabilities."

Also, one teacher who chose project concluded, "problem-based investigations teach students to produce solutions to problems, not merely to recognize solutions. Through the assessment conducted, I realized the weaknesses of my students. I will re-evaluate my teaching methods, sought [seeking] new ways to test learning."

The final quotation here is from one teacher who had taught for 39 years: "I have never tried out the interview-based assessment in my teaching life. I find it something new and worth trying. …[From the interview] I feel I might be too fast in rushing through the topics and did not give my students sufficient time to practise and consolidate what they had just learnt…. I must slow my pace of teaching and give more individual attention to those who need my assistance most." The teacher concluded, "I have to make myself more approachable and accessible to gain their trust in me that I am always available to their needs no matter how busy I am."

A general yet important finding emerged from the participants' work on the authentic task. That is, the teachers found that the concept of alternative assessment

was not integrated into the current textbooks, workbooks, or other teaching materials they were using, and almost all the questions or tasks that could be found in those books were typically traditional, and similar to traditional written test items. This fact seems to be generally true in the textbooks published in Singapore and some other Asian countries (e.g., see Ng, 2002; Fan & Zhu, 2000). As textbooks have important influence on teachers' teaching practice (e.g., see Fan & Kaeley, 2000; Krammer, 1985), it is clear that lack of such integration in the textbooks presents a major difficulty for teachers to integrate alternative assessment into their classroom instruction. Therefore, improvement of textbooks is needed in this area.

It should be pointed out that follow-up collaborations, as a result of the training program, were established between the researcher and a number of teachers on implementing the new modes of assessment into the real classrooms after the training programs. In particular, structured action research plans were initiated and then carried out in classroom by two teachers, one from the first intake on journal-based assessment, and the other from the second intake on oral-presentation-based assessment, which was later reported in *The Straits Times* (Nirmala, 2002). The results appeared to be beneficial for teachers in their professional development and for students in the learning of mathematics (see Yazilah & Fan, 2002; Seto, 2002).

Conclusions

This article documented the practice of a university-based in-service training program and analyzed its effects on teachers' development in the area of alternative assessment. Based on the data gathered in the study and the analysis presented above, the following general conclusions can be drawn.

First, both the concepts and techniques of alternative assessment are relatively new to mathematics teachers in Singapore schools, and the traditional written test is still largely dominant in teachers' assessment practice. Therefore, systematic training in this area is highly needed for school teachers, especially for those who had been in teaching profession for a long time.

Second, in-service training can be an effective way to promote their professional growth in the area of alternative assessment. In particular, one of the most helpful strategies in in-service training is to ask teachers to authentically integrate what they learned about alternative assessment into their classroom instruction. Moreover, as it is impossible to do so for prospective teachers in pre-service training, it suggests that compared to pre-service training, in-service training has unique advantages and is likely more effective in this area.

Some relevant comments are in order. Regarding the relative value of pre-service training and in-service training, recent studies have found that teachers generally believe that in-service training is to a large degree more useful than pre-service

training in developing their pedagogical knowledge (Fan, 1998; Fan & Cheong, 2002). The evidence provided in this study appears to be consistent with that finding. Furthermore, it appears that in-service training's unique advantages including in-service teachers' better professional background, relatively strong practical need and motivation, and the immediate applicability of the knowledge they learn in the training to their actual classroom teaching, as revealed in this study, are important reasons for the greater effectiveness of in-service training in teachers' professional development in the domain of pedagogy. Obviously, further studies are needed in order to get better understanding of this issue.

Finally, the study reveals that the current school curriculum does not well reflect the new development of assessment and hence there is a need to integrate the concept and content of alternative assessment into school curriculum, especially the textbooks, so the curriculum environment can facilitate teachers' using of alternative assessment in classrooms.

References

Adam, T. L. (1998). Alternative assessment in elementary school mathematics. *Childhood Education, 74*(4), 220-224.

Berenson, S. B., & Carter, G. S. (1995). Changing assessment practices in science and mathematics. *School Science and Mathematics, 95*(4), 182-186.

Clarke, D. (1997). *Constructive assessment in mathematics: Practical steps for classroom teachers*. Berkeley, CA: Key Curriculum Press.

Fan, L. (1998). *The development of teachers' pedagogical knowledge*. Ann Arbor, MI: UMI Dissertation Service.

Fan, L. (2001). Learning to integrate alternative assessment into mathematics instruction: The effects of in-service training. In S. K. Leung (Ed.), *Holistic review of the mathematics curriculum: What is next*? Hong Kong: Chinese University of Hong Kong, 92-105.

Fan, L., & Cheong, N. P. (2002). Investigating the sources of Singaporean mathematics teachers' pedagogical knowledge. In D. Edge & B. H. Yeap (Eds.), *Mathematics education for a knowledge-based era (Vol. 2)* (pp. 224-231). Singapore: AME.

Fan, L., & Kaeley, G. (2000). The influence of textbooks on teaching strategies: An empirical study. *Mid-Western Educational Researcher, 13*(4), 2-9.

Fan, L., & Zhu, Y. (2000). Problem solving in Singapore secondary mathematics textbooks. *The Mathematics Educator, 5*(1/2), 117-141.

Krammer, H. P. M. (1985). The textbooks as classroom context variable. *Teaching & Teacher Education, 1*(4), 273-278.

Kulm, G. (1994). *Mathematics assessment: What works in the classroom* (Chapter 10). San Francisco, CA: Jossey-Bass.

Leung, S. K. (Ed.). (2001). *Holistic review of the mathematics curriculum: What is next*? Hong Kong: Chinese University of Hong Kong.

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

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

Nirmala, M (2002). Pupils talk about maths in this class. *The Straits Times*, May 18, 2002, H11.

Ng, L. E. (2002). Representation of problem solving in Singaporean primary mathematics textbooks. Unpublished Master's Degree Dissertation, Nanyang Technological University.

Raymond, A. M. (1994). Assessment in mathematics education: What are some of the alternatives in alternative assessment. *Contemporary Education*, *66*(1), 13-17.

Richardson, K. (1988). Assessing Understanding. *Arithmetic Teacher*, *35*(6), 39-41.

Seto, C. (2002). Oral presentation as an alternative assessment in mathematics. In D. Edge & B. H. Yeap (Eds.), *Mathematics education for a knowledge-based era (Vol. 2)* (pp. 33-39). Singapore: AME.

Singapore Ministry of Education (2000). *Mathematics syllabus (for Primary and Lower Secondary)*. Singapore: Ministry of Education.

Stacey, K. (1987). What to assess when assessing problem solving? *Australian Mathematics Teacher*, *43*(3), 21-24.

Stempien, M., & Borasi, R. (1985). Students' writing in mathematics: Some ideas and experiences. *For the Learning of Mathematics*, *5*(3), 14-17.

University of Chicago School Mathematics Project (1995). *Assessment sourcebook: Transition mathematics*. Glenview, IL: Scott Foresman.

Van de Walle, J. (2001). *Elementary and middle school mathematics: Teaching developmentally* (Chapter 5). New York: Longman.

Yazilah, A., & Fan, L. (2002). Exploring how to implement journal writing effectively in primary mathematics in Singapore. In D. Edge & B. H. Yeap (Eds.), *Mathematics education for a knowledge-based era (Vol. 2)* (pp. 56-62). Singapore: AME.

Author:

Fan Lianghuo, Assistant Professor, National Institute of Education, Nanyang Technological University, Singapore. lhfan@nie.du.sg