Collaboration between Mathematics Facilitators and Preschool Teachers Using the Innovative "Senso-Math" Preschool Program

Dina Hassidov
Talpiot College of Education, Israel

Bat-Sheva Ilany
Hemdat Hadarom College

Received: 9 June 2015 / Accepted: 26 June 2017

This article presents a mixed-method study of the innovative "Senso-Math" preschool program and the reactions of both the facilitators, who underwent a special training program, and the preschool teachers in whose classes the program was implemented. The goal of the program is to enhance mathematical development in preschool children through the intervention of trained facilitators who bring the adjunct program into preschools. The results indicate a positive change in the attitudes of the facilitators to their professional calling and, after an adjustment period, a positive attitude overall regarding the facilitators' contribution to mathematics education in the preschool as evidenced by the significant relationships that developed between the facilitators and the preschool teachers.

Keywords · facilitators · mathematics education · preschool · kindergarten · "Senso-Math" Preschool Program-SMP

Background

In keeping with the global trend that advocates familiarity with mathematical concepts as early as preschool so as to build mathematical readiness for primary school, today's preschool teachers are expected to have sufficient knowledge to teach early mathematics in preschools. Research has established that children at preschool age are able to understand concrete mathematical processes, sometimes even abstract ones, and the earlier the children acquire mathematical experience, the more impact the experience has on their future development and abilities (Baroody, 2000).

It has been shown that teachers' attitudes are one of the main factors affecting children's attitudes towards mathematics (Philippou & Christou, 1998; Plucker, 1996) since teachers serve as a model for their students (Charalambous et al., 2009; Philipp, 2007). "Attitudes" are effective structures, sustainable over time, through which people react to certain things in a particular way (Fiske & Taylor, 2008; McLeod, 1992). When dealing with mathematics, the teachers' attitudes are reflected in the way learners study, feel, and think (Philipp, 2007; Charalambous et al., 2009).

Unfortunately, studies conducted in recent years indicate that teachers assigned to teach mathematics in preschool find themselves challenged, feeling they lack competency for the job. In part, this may stem from the teachers' negative personal experiences. However, it is also due to a want of professional knowledge; relevant training in teaching preschool mathematics is not often acquired in college (Ben-Yehuda & Ilany, 2008; Guo et al., 2011; Tiroshe & Graeber, 1990), meaning that teachers lack adequate knowledge to teach mathematics in preschool. Thus, in addition to the preschool teachers' normally heavy commitment load, they find themselves additionally

burdened with the responsibility of creating and enabling positive experiences in foundation mathematics for young learners without adequate training.

These studies and others have led to the realisation that suitable support programs must be developed to strengthen teachers' sense of their own competence to teach mathematics in preschool. Such support programs should be structured along current teaching principles: to develop quantitative, critical, and creative understanding; to direct towards thinking and understanding; and to encourage mathematical discourse (Pimm, 1987) and metacognitive processes (NCTM, 2000).

Preschool Children and Mathematics

According to one of Piaget's (1972) principles, toddlers are at a stage approaching readiness for formal and abstract learning. This is the period when a child's thought structures are established, and visual and verbal representations are built. The child's activity at this age is essentially intuitive, combining imitation and imagination. Perry & Dockett (2013) emphasise that young children can be powerful mathematicians and suggest ways for stimulating mathematical comprehension.

Developmental constraints mean that children adhere to sensory impressions and experience subjective vision that is considered egocentric. This leads to restrictions in the child's ability to reach generalisations (Vygotsky, 1962), hampering their natural ability in math unless these abilities are nurtured either in the home or in the school environment. In Australia, for example, one in four young children growing up in disadvantaged communities enter formal schooling without the necessary mathematical skills (Australian Early Development Census, 2012).

However, preschool children *do* have the ability to build concrete mathematical – sometimes even abstract – processes, and the earlier that children are exposed to the experience, the greater the child's mathematical development will be later on. In fact, there is indication that, through mediation, a change can be achieved in a child's ability to use basic logical reasoning. Developmental psychology emphasises that a suitable change in the physical-social environment of the child that provides opportunities to experience physical objects, speculate, argue, and explain (Kilpatrick et al., 2001) can encourage cognitive development, including in the areas of mathematics and mathematical language.

However, for this to happen, it is important for the child to solve problems that are relevant to his or her individual needs as a learner (Carpenter et al., 1998). In other words, children must be able to find and apply the relationship between the understanding of mathematics as abstract knowledge and its relevance to their everyday world.

Teaching Mathematics to Pre-schoolers: Training the Teachers

Since young children are essentially engaged in mathematics in daily life from birth (NAEYC & NCTM, 2002), preschool mathematics practice should develop their awareness so as to cultivate mathematical thinking at an early age. Indeed, preschool mathematics practice helps shape the child's future cognition, mathematical thinking, general thinking, and cognitive abilities (Clarke, Clarke & Cheeseman, 2006). In addition, the volume and quality of mathematics practice during preschool predict a child's success in math in primary school (Clements & Sarama, 2006, 2009). Neuroscience research shows that preschool mathematics activity is important. Clements (2001) maintains that the structure and organisation of the brain of developing pre-schoolers is affected by their learning experience, and that complex activities lead to increased brain development.

In fact, many early childhood mathematics curricula aim to place more emphasis on mathematics in early learning (see, for example, Australian Curriculum, Assessment and Reporting Authority (ACARA), 2009; Clements, 2007). An example is the Australian program "Let's Count" (2016) for children aged three to five, which aims to develop children's skills by encouraging them to notice, explore, and talk about numbers, counting, measurement, shapes, and patterns in everyday life.

Mulligan (2016) emphasises that the important question is how educators can effectively understand, and consequently promote, deep mathematical structural development from an early age. It is clear that teaching mathematics to pre-schoolers requires appropriate professional knowledge on the part of the preschool teacher. However, preschool teachers are not always prepared for such a task, due to the minimal (or lack of) training they receive in college in the realm of preschool teaching in general, and preschool mathematics in particular. Without sufficient, appropriate knowledge, the teacher, already overburdened, is hard-pressed to teach mathematics effectively. Furthermore, if the preschool teacher feels unequipped for the role of teaching mathematics, she may not present mathematics in a cheerful and pleasant manner to the children.

The teacher's attitude is a key factor influencing students' attitudes toward mathematics (Philippou & Christou, 1998) since teachers serve as role models for their students (Charalambous et al., 2009), and recent studies in various countries point to the difficulties that preschool teachers have regarding mathematics in general. Such personal, negative feelings may increase feelings of ineptitude regarding teaching the subject, especially if the teachers have not received adequate training for the role (Guo et al., 2011; Ilany et al., 2015).

The conclusion, therefore, is that there is a need to construct appropriate adjunct programs to encourage and empower preschool teachers to teach mathematics. Such programs should be based upon new pedagogical principles regarding the development of quantitative, creative, and analytic understanding; teaching for the purpose of constructing knowledge and understanding; and encouraging mathematical discourse and meta-cognitive thought processes (NCTM, 2000). Children thus develop the numerous skills needed for the successful transition to primary school.

Based on these principles, the Australian "Let's Count" program is an example of a program that provides training for early childhood educators, including how to support parents in developing the maths skills of their child using the take-home resource pack that is part of the kit. The "Senso-Math" preschool (SMP) program (Hassidov & Ilany, 2014) is also based on these principles.

The "Senso-Math" Preschool Program

The "Senso-Math" Preschool program (SMP)[i] is unique in that it promotes the professional mathematical knowledge of the preschool teacher by introducing into the classroom professional facilitators who model methods by which mathematics can be taught to pre-schoolers. SMP facilitators come to the preschool and work with the children in small groups. They provide the teachers with formal, didactic information regarding how children learn, demonstrate to the teacher how to work with the material, and engage the children. They are available to answer any questions the teacher may have. The preschool teacher observes the facilitator and becomes a partner in the teaching process. By providing guidance and assistance in presenting mathematics, the facilitators reduce the responsibility placed on preschool teachers to achieve the aforementioned goals.

The "Senso-math" approach teaches math using hands-on materials and experiential activities that encourage mathematical learning through dynamic experiences designed to encourage

mathematical reflective discourse. Children investigate mathematical aspects of day-to-day life using all their senses and are thus able to assimilate and shape mathematical concepts and models.

Special educational materials were designed and created for the SMP program to present varied, graduated exercises that follow the already established preschool curriculum. The mathematical concepts are taught through a combination of sensory and motoric activities, utilising their everyday experiences in a way that is appealing and engaging.

Three kits were produced for the facilitators to use in the classroom, one for each year of preschool, to accompany children from the ages of three to six years according to their cognitive maturity. Each kit consists of 30 learning units that correspond to the ten topics covered over the year as suggested by the Ministry of Education (seasons, holidays, etc.). Each topic is further divided into three customised units corresponding to three "styles" of learning: creative, structured, and motoric. Each unit includes detailed task cards and assistive materials that allow the teacher to create a rich, experiential, authentic mathematical learning environment and provide activities to allow the children to explore familiar concepts mathematically, learn the correct mathematical terms, and develop mathematical thinking. The task cards specify the purpose of the activity, number of participants, level of activity, and recommended accessories.

In addition, each child receives an individual kit that includes special teaching materials such as worksheets, "fun pages," card games, board games, and specially designed accessories and props. Some of the activities are meant to be taken home and shared with parents and siblings.

In each preschool, learning groups of up to ten children were set up, based on the teacher's recommendation. The small size of the group allows them to work individually, in pairs, or in a group activity. The children can successfully express themselves in the group but also work independently without giving up individual attention. The facilitator worked with the children once or twice a week, either during formal preschool hours, or in the afternoon, within the framework of after-school enrichment classes. Each session lasted for a period of 40 minutes for children aged four to six, and 30 minutes for children aged three to four.

The pedagogical and mathematical rationale of the "Senso-Math" teaching kits were initially tested in 20 preschools. The results of the initial program were validated through observation, data collection, and accompanying research, then were revised to further enrich the curriculum framework. After final approval by the Israel Ministry of Education, several hundred preschools were chosen to implement the program.

Figure 1. Facilitator's kit

Facilitator training

SMP facilitators undergo a two-year program that qualifies them to work independently teaching and promoting mathematics in preschools. The first year, qualified women (see below) participate in a 128-academic-hour program (20 meetings): 40 hours focus on the organisational aspect of naturally integrating the SMP into preschools, and 88 hours are devoted to mathematical content in early childhood education and practical work administering and facilitating the SMP in preschools.

Content covered includes teaching and learning methods, mathematics education, cognitive abilities of primary school children, and more. During the program, the facilitators are familiarised and shown how to use the unique "Senso-Math" kit, which includes all the paraphernalia needed for teaching the 30 extended activities each year, as an activity centre.

In the second year of training, facilitators undergo 28 hours of practical experience in primary schools, accompanied by one-on-one mentoring, as required. In addition, they receive 15 hours of professional guidance when they commence formal work. After completing the course, participants were qualified to work as autonomous teachers in the field.

Purpose of Study

The purpose of this study was to track the progress and attitudes of the facilitators as they implemented their training in preschool classrooms alongside preschool teachers, to discover any insights regarding the preschool teachers' acceptance and appreciation of the SMP program, and to determine how the SMP affected how they taught and related to mathematics in their classrooms.

Method

Population

All the preschool teachers were graduates of teacher training colleges, with more than three years of experience teaching in preschools. The preschool teachers had little or no background in early childhood mathematics since few college students are trained to teach preschool mathematics. All the preschools in the study were under the supervision of the Israeli Ministry of Education. The SMP activities in the preschools took place with approval of the Ministry of Education supervisors.

Of the 500 women who participated in the facilitator training program, 49 were chosen at random to take part in this study (Hassidov, 2014). The average education level of the study group participants was 14.5 years of schooling. Each participant had a requisite diploma or training certificate from a teachers' college or other school of higher education, were mathematically oriented, and could work as mathematical facilitators in preschool. Although all had a background in early childhood education, none of the participants had ever worked in preschool education. The average age of the participants was about 34 years old. The women were of diverse marital status, and came from various socio-economic, demographic sectors around the country (Israel Ministry of Education, 2009).

Research Tools

Research methods were both quantitative and qualitative. Data was collected via questionnaires and semi-structured interviews designed and conducted by the researchers.

The questionnaire comprised 22 statements (see Table 1) to ascertain the participants' attitudes to teaching mathematics in preschool and to the "Senso-Math" program. Fifteen facilitators (who were not included in the study group) validated the questionnaires. The 49 study participants were asked to rate the statements from 1 (not at all) to 5 (to a great extent). Negative statements were highlighted and were not included in the questionnaire.

After filling in the questionnaires, semi-structured interviews were conducted with all the study participants (n= 49) to clarify their attitudes. Relevant background information was also collected at this time, such as age, education, place of residence, occupation, and socioeconomic status.

Data collection was carried out three times: at the beginning of this study, at the completion of training, and a year post-training. Statements were divided into four categories: attitudes toward learning mathematics, development of professional confidence, self-confidence in teaching mathematics in particular and evaluation of the program.

Results and Discussion

Summary of Quantitative Results

The results of the survey carried out a year post-training are presented in Table 1, and a summary of the overall results regarding the study participants' attitudes regarding mathematics in preschool, how the facilitator training course developed their professional confidence and their self-confidence in teaching mathematics, and their satisfaction with the program is shown in Table 2. It shows that, overall, the 49 participants viewed the course favourably and considered it a viable career alternative.

Table 1 presents a detailed picture of the participants' responses. The 22 statements are divided according to categories. The number of responses for each level, rated from 1 (not at all) to 5 (to a great extent), are listed, along with the average rating.

Statements 1-7 related to teaching mathematics in preschool. The statement that had the highest average rating was the one regarding the importance of having children learn mathematics already in their preschool years, and the statement that received the lowest rating was "Anyone can enjoy learning mathematics." However, the average ratings for all the statements are in the range of 4 and above, implying that most facilitators were aware of the importance of early mathematics education for developing a positive attitude to math and making math a subject that everyone can learn. The results show that the facilitators thought that having children learn mathematics as early as preschool was important (average 4.65) and would help them develop a positive attitude to the subject (average 4.51), and that anyone can learn mathematics (average 4.15).

Table 1. *Responses to the Questionnaire*

#	Statement	5	4	3	2	1	Av.
	Attitudes regarding the study of mathematics						
1	It is important for children to start learning mathematics in preschool.	33	13	2	--	--	4.65
2	Children of preschool age can learn mathematics.	29	15	4	--	--	4.52
3	If the basics of mathematics are learned before first grade, the child will develop a positive attitude towards the subject.	27	20	2	--	--	4.51
4	If the basics of mathematics are learned before first grade, the child will develop a positive attitude towards the subject.	27	20	2	--	--	4.51
5	Anyone can learn mathematics.	18	18	11	--	--	4.15
6	I see my future in teaching children mathematics.	19	15	13	1	--	4.08
7	Anyone can enjoy learning mathematics.	16	14	14	4	--	3.88
	Development of professional confidence						
8	Anyone who aspires to succeed can do so at any age.	20	18	9	1	1	4.40
9	Unemployed women should be concerned about their professional development.	2	11	10	10	16	4.12
10	Teaching mathematics in preschool requires readiness, knowledge, and professional maturity.	6	11	13	11	7	3.79
11	The training encouraged me to start teaching mathematics in preschool.	6	10	15	7	4	3.67
12	I feel I can incorporate the SMP into the preschool.	14	17	11	2	3	3.57
13	The training gave me professional confidence.	23	20	4	--	--	3.17
14	The training encouraged me to pursue my professional aspirations.	11	16	13	2	3	2.96
15	I am considering making mathematics teaching my main profession.	8	15	19	3	1	2.45
	Statements about self-confidence in teaching mathematics:						
16	The training gave me confidence to teach mathematics.	6	10	15	7	4	3.17
17	Had I not participated in the SMP, I would not have confidence to teach mathematics*.	1	2	9	5	29	1.72
	Statements about satisfaction with the program:						
18	The SMP facilitators' kit is a valuable aid for facilitating mathematics in preschool.	17	15	4	1	--	4.30
19	The SMP activity pages were valuable for teaching mathematics in the preschool.	19	14	9	1	--	4.19
20	The course was conducted professionally.	20	14	7	1	1	4.19
21	The training gave me tools to facilitate mathematics in preschool.	19	14	11	--	--	4.18
22	The training gave me tools to teach mathematics in preschool.	19	18	7	1	1	4.15

*The overall low score to this question could have been due to it having been presented as a negative statement.

Statements 8-15 examine the attitudes regarding professional confidence. The statement that received the highest average score was "Anyone who aspires to succeed can do it at any age," whereas the statement "I am considering making mathematics teaching my main profession" received the lowest score. Thus, although the results indicate that training encouraged facilitators to begin teaching mathematics in preschool, and that teaching preschool mathematics requires readiness, knowledge and professional maturity (statement 10), they did not necessarily show readiness to continue in this area. The results indicate that the training encouraged the facilitators to begin teaching mathematics in preschool (average 3.67), and gave them the ability to integrate the SMP into the preschool (average 3.57). The facilitators realised that teaching preschool requires readiness, knowledge and professional maturity (average 3.79).

Statements 16-17 show the participants' attitudes towards their self-confidence in teaching mathematics. The results show that the participants were convinced that the course gave them confidence to teach mathematics, which implies a high level of self-confidence.

Statements 18-22 show the results of the questions dealing with the participants' satisfaction with the SMP and the course itself. An examination of the averages indicates that the SMP was considered valuable for teaching mathematics in preschool. In general, most of the statements relating to the program and accompanying kit won scores of over 4. Participants showed satisfaction with the tools they were given for teaching mathematics in preschool (average 4.15), with the training for facilitating mathematics in preschools (average 4.18), with the teaching materials (average 4.19), and with the facilitator kits (average 4.30). In addition, the participants felt that the course was conducted in a professional manner (average 4.19), and most indicated that they would recommend the program to a friend (average 3.96).

Table 2. *Attitudes of Participants towards Various Aspects of the SMP*

Attitudes of participants	Average	(sd)
Attitude regarding the study of mathematics	4.34	(0.40)
Development of professional confidence	3.46	(0.56)
Developing self-confidence in teaching mathematics	2.19	(0.90)
Evaluation of the program	4.29	(0.64)
Would you recommend participating in the SMP program to a friend?	4.04	(1.19)

The values presented in Table 2 were determined based on a statistical factor analysis of the questions that appeared on the questionnaire (see Table 1).

The statements are divided by category:

Attitude regarding the study of mathematics. It is important that children start learning mathematics in preschool; Children of preschool age can learn mathematics; If the basics of mathematics are learned before first grade, the child will develop a positive attitude towards the subject; Anyone can learn mathematics; I see my future in teaching children mathematics; Anyone can enjoy learning mathematics.

Development of professional confidence. Anyone who aspires to succeed can do so at any age; Unemployed women should be concerned about their professional development; Teaching mathematics in preschool requires readiness, knowledge, and professional maturity; The training encouraged me to start teaching mathematics in preschool; I feel I can incorporate the SMP into

the preschool; The training gave me professional confidence; The training encouraged me to pursue my professional aspirations; I am considering making mathematics teaching my main profession.

Statements about self-confidence in teaching mathematics. The training gave me confidence to teach mathematics; Had I not participated in the SMP program, I would not have confidence to teach mathematics.

Statements about evaluation of the program. The training gave me tools to teach mathematics in preschool; The training gave me tools to facilitate mathematics in preschool; The SMP activity pages were valuable for teaching mathematics in the preschool; The SMP facilitators' kit was a valuable aid for facilitating mathematics in the preschool; The course was conducted professionally.

The attitudes of the participants regarding the study of mathematics were, on the whole, favourable: the average ratings for all the statements are in the range of 4 and above. The statement that received the highest average rating was the one regarding the importance of having children learn mathematics as early as preschool (4.65, average). The statement that received the lowest rating was "Anyone can enjoy learning mathematics" but its rating was still close to 4. The results indicate that the facilitators thought it was important for children to learn mathematics as early as preschool, and that this would help the children develop a positive attitude to the subject (4.51).

Regarding professional confidence, the statement that received the highest average score was "Anyone who aspires to succeed can do it at any age." Moreover, while the answers indicate that the training was successful (statements 11, 12, and 13), statement 15, "I am considering making mathematics teaching my main profession," received the lowest score.

Regarding the participants' satisfaction with the SMP program and the training course, results (average of all statements over 4, with a clear majority of answers at levels 5 or 4) indicate that the SMP was considered significant for teaching mathematics in preschool. Participants indicated satisfaction with the tools, kit, and activity pages, as well as with the professional way in which the course was conducted.

Other aspects of our study examined the participants' satisfaction with the course correlated with factors such as number of years of education and age and the number of children in their preschool groups. See Table 3. A Pearson correlation was used in which the coefficients can be in the range of zero to 1 or zero to -1. The closer the coefficient is to zero, the weaker the correlation. A negative correlation indicates an inverse relationship between the variables. Table 3 indicates that higher education is correlated with lower satisfaction with the program and with less positive attitudes towards the program itself. Moreover, more educated women showed less support for professional development. These correlations convey an expression of criticism that may be due to the women's level of education. Perhaps highly educated women are more critical in general and this criticism is expressed by the attitudes they expressed towards the program. More detailed results can be found in Hassidov & Ilany (2014).

Table 3. *Correlation between Variables and Statements Regarding Satisfaction with the Program*

	No. of children	Age	Years studied
Would you recommend the SMP to a friend?	-0.26	-0.17	-0.40(**)
Participants attitudes towards teaching mathematics in preschool	-0.13	-0.03	-0.31(*)
Professional development	0.03	-0.12	-0.47(**)
Development of self-confidence	-0.05	-0.07	-0.13
Program evaluation	-0.29	-0.36(*)	-0.42(**)

* P < 0.05; ** p <0.01

Table 3 presents correlations between the satisfaction of the participants with the course and factors regarding education, number of children, and age.

Summary of Qualitative Results

Policy changes regarding teaching mathematics at preschool, along with the need to prepare children mathematically for the transition from preschool to primary school, place a great deal of responsibility on the preschool teacher. The SMP qualifies facilitators by training them specifically to be adjunct mathematics teachers in preschool, thus expanding the options and educational resources available for teaching preschool mathematics.

A year after the SMP pilot program, a large proportion of the 500 course participants (75%) had been integrated into preschools as facilitators. In interviews conducted at this time, their experiences regarding their integration into the preschool system were recorded. The qualitative results support, strengthen, and clarify the quantitative data.

The facilitators felt that the teachers realised the profound need to teach mathematics as early as preschool. The general impression was that the facilitators created a rich, diverse environment for learning mathematics in the preschool, and that teachers benefitted from the presence of a professional colleague who came once or twice weekly to take responsibility for mathematics instruction. The facilitator brought learning materials for the children and the teacher received guidance as to how to continue the experience during the week. The facilitators reported that the teachers observed their activities with the children and repeated them during the course of the week. One of the facilitators reported that, as a result of her activity, the teacher's policy regarding mathematics changed:

> The teacher told me that since I had begun coming to the preschool … she has begun integrating daily mathematical activities into her program.

Often, the considerable task load placed on a preschool teacher over the course of the academic year does not allow her sufficient time to teach mathematics in her classes. On the other hand, the facilitator's only task is to teach mathematics. This lifts a huge load of responsibility from the preschool teacher's shoulders.

However, accounts indicated that the relationship between the facilitator and teacher did not always start out smoothly. Some of the preschool teachers seemed to feel threatened:

> Why do I need someone else—an "expert" in mathematics—to come every week? What can they explain that I can't?

Some teachers initially suspected that the facilitators represented the Ministry of Education, and were there to observe the teacher's ability to teach mathematics. Since the program was implemented in the preschools through mathematics teaching inspectors affiliated with Ministry of Education, the preschool teachers were under the impression that the facilitators would be initiating a specific program to advance the teachers' efficacy and professionalism vis-à-vis teaching mathematics in the preschool. The teachers were suspicious of the process, and lacked a clear idea of what would occur regarding teaching mathematics in their classes. They did not realise that the facilitators were there to lighten their load, not to add to it.

Thus, at the beginning of the program the teachers tended to be uncooperative and did not give the facilitators freedom to carry out the program as they wished. For example, one of the facilitators reported:

> I was anxiously looking forward to working in a preschool… I had a good feeling that I could contribute and collaborate with the teacher… However, it seemed I was received with some trepidation, and there was a sense of contrariness on the part of the teacher… She couldn't find a suitable spot for me to work… or she would say that the children were busy doing some other activity… Every time I got started, I would hear mumbling that made me feel she wasn't thrilled to have me in the class.

After a period of adjustment, once the facilitators had received guidance to deal with the teachers' reluctance, the situation changed. The facilitator continued her account:

> The course instructor accompanied me and gave me some advice, and I understood the teacher's apprehension about the situation… After several weeks, during which I had been teaching and the teacher had been observing, things started to change for the better. At the end of the year, the teacher asked me to explain the models to her, and she asked me to help her prepare a mathematics program for next year. …She also asked me to come to the parents-teachers meeting to update the parents on what we had done in the class, and to explain how mathematics learning-aids had been incorporated into the play area.

One preschool teacher who taught 4 to 6 years old reported:

> After a few lessons during which I had not been asked to do anything, I understood how much simply observing her and her way of working with the materials contributed to me… After the facilitator left the preschool, I, myself used the teaching materials that she had left, and I saw how easy it was to teach the children with them.

Another teacher reported:

> After a few weeks… I started to look forward to her arrival. Believe me, I stood at the door and waited for her. I was keen to tell her what had happened the day before, when I taught the children about patterns: the children told me that Nadine's socks are also patterned because they have stripes—blue, red, green, blue, red, green. Then all the children started looking for patterns on their classmates' clothes. It made me so happy!

A third preschool teacher said:

> I never had anyone with whom I could discuss how to teach mathematics in my classes; now, I have someone to talk to every week, and I can consult with her. My supervisor is aware of this too.

As time passed, the instruction of mathematics in the preschools bloomed into full cooperation between the teacher and facilitator. The facilitator taught the children mathematics once or twice a week, while the teacher observed the activity. The teacher continued the facilitator's activities during the week, to reinforce the studies for the children.

As one of the facilitators reported:

> At first, the teacher objected to having me in her preschool teaching mathematics. But after several months, we were collaborating nicely, and she told me that she now realised that teaching preschool mathematics is important and requires professional training; something that I, the facilitator, had attained and that she lacked.

Conclusions

The global trend today favours access to mathematics at a young age. Recent years have seen a change regarding the importance of the learning environment and the teacher's role, with a change from the traditional environment, where the teacher transmits knowledge, to an active and constructivist learning environment (Cobb, 1996). This change has led to a transformation in the teacher's role and responsibilities. In this new environment, the teacher serves more as a facilitator or mediator who encourages learning by enabling opportunities for the students to engage in interesting activities. The students take on the responsibility for constructing their learning experience from the knowledge available. Fostering such experience requires a teacher to have professional knowledge.

The unique SMP provides a solution for a clearly-defined need in the current education system, where mathematics must be taught to children at a young age to prepare them for their mathematics studies in primary school.

This study indicates that the SMP has had a great impact on both populations: those who studied to be facilitators as a means of professional development, and the heavily burdened preschool teachers who do not have enough knowledge or training to adequately provide mathematical instruction in their classes. The presence of facilitators in the preschool transforms mathematics into a subject that is interesting, appealing, challenging, and has a central part of the daily routine. The preschool teachers came to realise that teaching preschool mathematics is an area that requires professional training.

Acknowledgements

We thank Marganit Klugman for her part in developing the SMP program and training the facilitators.

References

Australian Curriculum, Assessment and Reporting Authority [ACARA]. (2009). Australian curriculum: Papic, Mulligan, and Mitchelmore Mathematics. Retrieved from www.australiancurriculum.edu.au/Mathematics/Curriculum/F-10

Australian Early Development Census 2012 Summary (2013). Retrieved from file:///C:/Users/admin/Documents/%D7%93%D7%99%D7%A0%D7%94%20%D7%97%D7%A1%D7%99%D7%93%D7%95%D7%91/%D7%94%D7%AA%D7%A4%D7%AA%D7%97%D7%95%D7%AA%20%D7%9E%D7%95%D7%A9%D7%92%D7%99%D7%9D%20%D7%9E%D7%AA%D7%9E%D7%98%D7%99%D7%99%D7%9D/%D7%A2%D7%99%D7%AA%D7%95%D7%9F%20%D7%90%D7%95%D7%A1%D7%98%D7%A8%D7%9C%D7%99/AEDC_2012_Summary_Report_%201501-083-5-2.pdf

Baroody, A. J. (2000). Does mathematics instruction for three- to five-year-olds really make sense? *Young Children*, *55*(4), 61–67.

Ben-Yehuda, M., & Ilany, B. (2008). *Pituach Chashiva matematit bagil harach: teoria, mechkar, uma'aseh behachsharat morim.* [The development of mathematical thinking in young children: theory, research and practice in training teachers]. Tel Aviv: Machon Mofet Publications.

Carpenter, T. P. (1988). Teachers' pedagogical content knowledge of students' problem solving in elementary arithmetic. *Journal for Research in Mathematics Education*, *19*(5), 385–401.

Charalambous, C. Y., Panaoura, A., & Philippou, G. (2009). Using the history of mathematics to induce changes in preservice teachers' beliefs and attitudes: insights from evaluating a teacher education program. *Educational Studies in Mathematics*, *71*(2), 161–180. http://doi.org/10.1007/s10649-008-9170-0

Clarke, B., Clarke, D., & Cheeseman, J. (2006). The mathematical knowledge and understanding young children bring to school. *Mathematics Education Research Journal*, 18(1), 78–103.

Clements, D. H. (2001). Mathematics in the preschool. *Teaching Children Mathematics*, *7*, 270–277.

Clements, D. H., & Sarama, J. (2006). Your child's mathematical mind. *Scholastic Parent & Child*, (October, 2006), 30–37.

Clements, D. H., & Sarama, J. (2009). *Learning and teaching early math: The learning trajectories approach*. New York, NY: Routledge.

Cobb, P. (1966). Accounting for mathematical learning in social context of the classroom. Presented at the ICME 8, Seville, Spain.

Fiske, S. T., & Taylor, S. E. (2008). *Social cognition: from brains to culture*. Boston: McGraw-Hill Higher Education.

Guo, Y., Justice, L. M., Sawyer, B., & Tompkins, V. (2011). Exploring factors related to preschool teachers' self-efficacy. *Teaching and Teacher Education*, *27*(5), 961–968. http://doi.org/10.1016/j.tate.2011.03.008

Hassidov, D. (2014). Evaluating facilitator training for the "Senso-Math" preschool mathematics program. Presented at the IICE-2014, Dublin, Ireland.

Hassidov, D., & Ilany, B. S. (2014). A Unique Program ("Senso-Math") for teaching mathematics in preschool: evaluating facilitator training. *Creative Education*, *05*(11), 976–988. http://doi.org/10.4236/ce.2014.511112

Ilany, B., Almog, N., Ben-Yehuda, M., & Rosenthal, I. (2015). Developing mathematics teaching in kindergarten. *Creative Education (CE)*.

Israel Ministry of Education. (2009). *Curriculum for the education of mathematics in early childhood (core mathematics program)*. The Department for the Development of School Curricula, Israel Ministry of Education.

Kilpatrick, J., Ed, Swafford, J., Ed, Findell, B., Ed, & National Academy of Sciences - National Research Council, W., DC. Center for Education.

Let's Count, (2016). Retrieved from: www.thesmithfamily.com.au/campaigns/lets-count-program

McLeod, D. B. (1992). Research on affect in mathematics education: a reconceptualization. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 575–596). New York: Macmillan.

Mulligan, J. T. (2016) Promoting early mathematical structural development though an integrated assessment and pedagogical program. *Program of the 13th International Congress on Mathematical Education Topic Study Group 1: Early childhood mathematics education*, 24-31 July 2016, University of Hamburg.

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

NCTM position statement early childhood mathematics: promoting good beginnings. (2002). *Teaching Children Mathematics*, *9*, 24–25.

Perry, B., & Dockett, S. (2013). Reflecting on young children's mathematics learning. In L. English & J. Mulligan (Eds.), *Reconceptualising early mathematics learning* (pp. 149-161). Dordrecht: Springer.

Philipp, R.A. (2007). Mathematics teachers' beliefs and affect. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 257–315). Charlotte, NC: Information Age Publishing.

Philippou, G. N., & Christou, C. (1998). The effects of a preparatory mathematics program in changing prospective teachers' attitudes towards mathematics. *Educational Studies in Mathematics*, *35*, 189–206. http://doi.org/10.1023/A:1003030211453.

Piaget, J. (1972). *The psychology of the child*. New York: Basic Books, Inc.

Pimm, D. (1987). *Speaking mathematically: communication in mathematics classroom*. London: Routledge & Kegan Paul.

Plucker, J. A. (1996). Secondary science and mathematics teachers and gender equity: Attitudes and attempted interventions. *Journal of Research in Science Teaching*, *33*(7), 737–751. http://doi.org/10.1002/(SICI)1098-2736(199609)33:7<737::AID-TEA3>3.0.CO;2-O

Tirosh, D., & Graeber, A. O. (1990). Evoking cognitive conflict to explore preservice teachers' thinking about division. *Journal for Research in Mathematics Education*, *21*(2), 98. http://doi.org/10.2307/749137

Vygotsky, L. (1962). *Thought and language*. (E. Hanfmann & G. Vakar, Eds.). Cambridge: MIT Press. Retrieved from http://content.apa.org/books/11193-000

Authors

Dina Hassidov
Talpiot College of Education, Israel
email: hasidov@netvision.net.il

Bat-Sheva Ilany
Hemdat Hadarom College, Netivot, Israel
email: bat77i@gmail.com

[i] Program developers: D. Hassidov, M. Klugman