Preschool children's performance and self-efficacy on mathematical and non-mathematical tasks

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1. Introduction and background

It is widely accepted today that both cognitive and affective structures are significantly related to learning (e.g. Ainley, 2006). Among the affective variables, a person's self-efficacy beliefs have been shown to be related to other affective variables, such as motivation, as well as to cognitive structures such as cognitive processing. Bandura (1986) defined self-efficacy as "people's judgments of their capabilities to organize and execute a course of action required to attain designated types of performances" (p. 391). His social cognitive theory calls for considering the relationship between psychodynamic and behavioristic factors, as well as personal beliefs and self-perception, when explaining human behavior.

Most studies on students' self-efficacy focus on children in or above elementary schools. So far, only few studies addressed preschool children's self-efficacy. This may be due to children's difficulty in differentiating between what is real and what they desire to be real (Stipek, Roberts, & Sanborn, 1984). Research finding are mixed. Some studies have found that young children may incorrectly associate effort with competency (Ruble, Eisenberg, and Higgins, 1994; Stipek & MacIver, 1989). Madigan, Winsler, Maradiaga, and Grubba (2002) found that preschoolers (aged four years old) were not able to consistently report on their own level of competence, be it cognitive competence or physical competence. In addition, there was a lack of association between children's reported competencies and their teachers' reports. Other studies have found that young children are able to understand the process of self-evaluation and may fairly judge their own competence (Anderson & Adams, 1985). According to Wilson and Trainin (2007) previous studies of young children's perception of their competence may not have been domain-specific enough. They argued that when children are asked generally worded questions, they tend to rate their competence as high and global. These researchers reported that children as young as first graders are able to differentiate between their self-efficacy judgments

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for reading, writing, and spelling when specific tasks are referenced. To the best of our knowledge, no studies have specifically investigated preschool children's self-efficacy related to their performance of mathematical tasks.

Our study focuses on kindergarten children, the year before entering first grade. On the one hand, the students are quite young, 5-6 years old. On the other hand, during this year, much guided learning takes place with the intention of preparing children to meet the demands of more formal schooling.

Self-efficacy beliefs are not only domain specific (e.g. mathematics, history, science) and content specific (e.g. within the domain of mathematics there is numeracy, patterns, geometry, etc.), but may well be task specific (e.g. what is the child asked to do) and situation specific (e.g. is the task implemented in class, outside, individually, in a group) (Pajares, 1996; Zimmerman, 2000). Thus, the aim of this study is to explore children's self-efficacy beliefs related to specific tasks that are typical and familiar of those performed in kindergarten, both mathematical as well as non-mathematical tasks, and to compare these beliefs with actual performance.

2. Method

The participants of this study included 52 kindergarten children, ages 5-6 years old, living in low socio-economic neighborhoods in Israel. All attended municipal kindergartens in their local neighborhood in the morning, and were scheduled to enter first grade during the following school year.

The research took place in the last month of the school year. A structured interview was developed for this study interweaving questions related to self-efficacy with questions related to knowledge. All children were interviewed individually in a quiet corner of the Kindergarten. The interviewer recorded both utterances and gestures. Questions were based on tasks typically performed in kindergarten. Some of the tasks were based on national preschool curricular guidelines while others were based on activities that teachers reported implementing in their kindergartens.

The first two sets of questions were related to the task of sorting items. Asking children to sort items is often used in kindergarten to teach children various concepts. The Israel National Preschool Science and Technology Curriculum (2009) states that inquiry based learning should include collecting, sorting, and comparing data. Thus,

asking children to sort items was considered to be a familiar task for the participants. The first two questions are presented and described below. Each question had three parts.

Question 1a: I have here cards and on each card is a picture of a tree, bird, or dog. Do you think you will be able to sort the cards and put the trees together in one group, the birds together in a second group, and the dogs together in a third group?

Question 1b: Are you very sure or a little bit sure?

Question 1c: Here are cards with pictures of trees, birds, and dogs. Place the cards with the trees in one bowl, the cards with the birds in a second bowl, and the cards with the dogs in a third bowl. (The children are given a pile of five cards and three bowls. There are two cards with one bird on each, two cards with one tree on each, and one card with one dog on it. We purposely presented the children with only one card of a dog in order to see if they would accept having only one item in a group or would place the dog with a different group believing that a group must have one more than item. According to Linchevski and Vinner (1998) a common misconception is that a set must be composed of more than one element.)

Taken together, the first two questions created a 4-point scale describing children's belief in their ability to sort the pictures mentioned. For example, if a child answered "yes" to question 1a and "a little bit" to the question 1b, his self-efficacy was graded to be3. If he answered "no" to the question 1a and "very sure" to question 1b, his self-efficacy was graded to be 1. The third question, question 1c, was in essence the implementation of the task. It is important to note that for this task, as well as for the tasks which follow, children were not given any feedback as regard to their performance. In other words, they were not told if they sorted the cards correctly or not. This is important because positive or negative feedback may have then influenced their self-efficacy beliefs regarding other similar tasks.

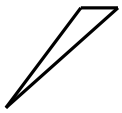
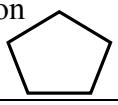
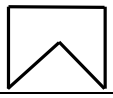
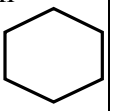
The second question and task were the same as the first except that it was related to sorting different types of birds. Children were asked about their ability to sort doves, ducks, and wagtail birds and were then requested to sort cards with pictures of doves, ducks, and wagtail birds. We hypothesized that this task would be more difficult than the first because of the need to distinguish between different types of birds. While dogs, birds, and trees share few properties, doves, ducks, and wagtails have many

properties in common. On the other hand, children in kindergarten (in Israel) are taught about nature and the different birds which appear in different seasons. The names of the above birds as well as their appearances were explicitly discussed in their kindergartens.

The third, and fourth questions were mathematics related tasks. Each of the tasks was taken from the Israel National Preschool Mathematics Curriculum (2008). According to the curriculum guidelines, kindergarten children should engage in geometry activities. By the end of kindergarten, children should be able to identify a variety of polygons, explaining their reasoning by pointing to critical attributes of shapes such as the number of sides and vertices. Teachers are encouraged to present their young students with a variety of shape tasks such as sorting, drawing, and copying different shapes.

In choosing the figures, both mathematical and psycho-didactical dimensions were considered (see Table 1). When considering triangles, the equilateral triangle standing on a base is considered a prototypical triangle and thus intuitively recognized as a triangle, accepted immediately without the feeling that justification is required (Hershkowitz, 1990; Tsamir, Tirosh, & Levenson, 2008a). A "narrow" and "pointy" triangle is considered a non-intuitive example because it is commonly categorized as non-triangle due to its “skinniness” (Clements, Swaminathan, Hannibal, & Sarama, 1999.). Whereas a circle is considered an intuitive non-example of a triangle, the pizza wedge “triangle” is considered a non-intuitive nonexample because of visual similarity to a prototypical triangle (Tsamir, Tirosh, & Levenson, 2008a). Similarly, the regular pentagon was thought to be easily recognized by children who had been introduced to pentagons whereas studies have shown that even among children who had been introduced to pentagons, the concave pentagon is more difficult to identify (Tsamir, Tirosh, & Levenson, 2008b). The nonexamples of each shape were also chosen in order to negate different critical attributes. Due to the young age of the children, we chose to limit the amount of figures presented to each child and thus did not include in this study intuitive nonexamples. Finally, we hypothesized that, in general, the triangle would be known to the children from their surroundings whereas the pentagon is a figure less known but part of the preschool mathematics curriculum and thus it could be that identifying pentagons would be more difficult than identifying triangles.

Table 1: The set of figures presented in this study

Is this a…	Intuitive example	Non-intuitive example	Non-intuitive non-examples	
triangle?	Equilateral triangle 	Scalene triangle 	Rounded-corner "triangle" 	Pizza wedge "triangle" 
pentagon?	Regular pentagon 	Concave pentagon 	Curved-sides "pentagon" 	Hexagon 

Question 3a: If I show you a drawing of a shape, will you be able to tell if the shape if is a triangle?

Question 3b: Are you very sure or a little bit sure?

Questions 3c- 3g: The interviewer shows the child four figures (see Table 1) and for each figure the interviewer asks, "Is this a triangle?"

Questions 4a – 4g were the same as questions 3a- 3g except that they related to pentagons instead of triangles (see Table 1). Identifying pentagons is also stipulated in the curriculum guidelines and thus it was deemed that children would be familiar with pentagons. On the other hand, this task was considered to be more difficult than identifying triangles due to its uncommonness outside of the kindergarten classroom.

The fifth and sixth questions were related to reciting the letters of the Hebrew and English alphabet respectively. As with all the other questions, self-efficacy beliefs were investigated prior to actual implementation of the task. The Israel National Preschool Literacy Curriculum (2007) places great emphasis on reading and writing readiness during the preschool years. According to the guidelines, by the end of kindergarten children should be able to recite all of the letters of the Hebrew alphabet, recognize the symbols and know how the letters sound phonetically. Thus, being asked to recite the letters of the alphabet was deemed to be a familiar task for the participants, one in which they had much practice in Hebrew. On the other hand, at this age, children in Israel are not expected to learn a second language. Still, English is not unheard of. It is both seen and heard on an almost day to day basis. Many store signs and street signs, are written in both Hebrew and English and many television

shows are in English. Thus, we felt that children would understand the request to recite the English letters, although we did not expect any of the participants to be able to do so beyond possibly saying A, B, and C.

As described above, results of self-efficacy questions were graded on a 1-4 scale, 4 signifying a strong belief in one's ability to perform the specific task. Implementation of the task was analyzed according to correctness. For the sorting tasks, either the child sorted correctly the pictures or did not. When reciting the Hebrew and English alphabet, only a perfect recitation, without any mistakes, was scored as a correct implementation. Regarding the triangle and pentagon identification tasks, a mean grade was configured for each child with respect to the shape. Four figures were presented for each shape. Thus, the final triangle and pentagon grade was configured as the number of correct identifications out of four.

3. Results

In this section we report on the results of the self-efficacy beliefs of the children as well as their performance on the tasks.

The results for are reported in Table 2. Recall that self-efficacy beliefs were measured using a four-point scale, four being the strongest positive belief. Frequencies of correct performances are reported for all non-geometry tasks. For the geometry tasks, the mean score for each group is given.

Table 2: Children's self-efficacy beliefs and performances on each task

Task (N=52)	Self- efficacy beliefs	Correct performances frequency
Sorting birds, trees, dogs	3.7	90
Sorting types of birds	3.9	54
Identifying triangle	3.8	73*
Identifying pentagon	3.6	68*
Reciting the letters of the alphabet in Hebrew	3.8	77
Reciting the letters of the alphabet in English	1.4	2

* These figures are mean scores

Looking first at the self-efficacy measures, except for the task of reciting the English alphabet, all children exhibited high self-efficacy beliefs related to their ability to perform the different tasks. On the other hand, looking at task performances, high self-efficacy did not always go hand in hand with high performance. For example, children had almost the same self-efficacy with respect to sorting birds, trees, and dogs as they did for sorting a variety of different birds. Yet, while 90% of the children correctly sorted the birds, trees, and dogs only 54% of the children correctly sorted the variety of birds. This is a noticeable difference. From this, we may be tempted to conclude that young children at the end of kindergarten cannot accurately assess their ability to perform tasks.

However, taking a closer look at the self-efficacy measures, we note that the range of the mean self-efficacy beliefs (excluding the exceptional task of reciting the English alphabet) was between 3.6 and 3.9. While the self-efficacy measures of four tasks were 3.7-3.9, children's self-efficacy score related to their ability to identify a pentagon was 3.6. The task of identifying pentagons was similar in nature to the task of identifying triangles, yet children's self-efficacy with regard to their ability to identify triangles, 3.8, was higher than their self-efficacy to identify pentagons. This coincides with the children's performance of this task. Children were more successful when it came to identifying triangles than when identifying pentagons. Thus, taking into consideration a range from 3.6 to 3.9, children had a correct sense that they were less likely to be able to perform the pentagon task than the other tasks.

We now consider the task of reciting the English alphabet. Recall that English is not the children's native language and it is not spoken by most of the children. Results of this task were exceptional for several reasons. First, consider the mean self-efficacy score of the children. It was considerably lower for this task than any of the other scores, including the relatively low self-efficacy score of the pentagon. This was the only task for which children did not believe in their ability to perform the task. Second, consider the performance. Not surprisingly, only two children were able to perform this task. Third, consider the relationship between the self-efficacy score and performance. It is the one task for which children accurately assessed their inability to perform.

Finally, an interesting phenomenon occurred when children were asked if they believed that they could recite the alphabet in Hebrew. Seven children (11%) did not

answer this question. Instead, they immediately began to recite the Hebrew alphabet and did so correctly. This was the only task which children could perform without the interviewer's intervention (i.e., no cards were necessary for its implementation). It could be that the task of reciting the Hebrew alphabet was so familiar and ingrained that some children automatically began reciting the alphabet, ignoring the interviewer's self-efficacy question. It could also be that immediate recitation of the alphabet was an outcome of a very high self-efficacy, as if the children were saying to themselves, "Why bother answering the question when I can show the lady how I do it." Notably, a similar response for a different task might have been if a child did not answer the self-efficacy question but instead requested the cards in order to perform the task. Yet, this did not happen.

4. Summary and discussion

The guided aim for this study was to explore children's self-efficacy beliefs related to specific tasks that are typical and familiar of those performed in kindergarten and to compare these beliefs with actual performance.

Investigating relations between self-efficacy beliefs and actual performances, results do not all point in the same direction. Excluding the alphabet tasks, it seems that for tasks which we hypothesized to be more difficult, self-efficacy beliefs were less in line with performance. For example, in the shape identification tasks, we hypothesized that identifying pentagons would be more difficult than identifying triangles, and for that task, self-efficacy was less in synchronization with performance. In other words, it could be that the difficulty of tasks moderates whether and how self-efficacy relates to task performance. On the other hand, when asked to assess their ability to recite the English alphabet, a very difficult task for children in Israel, children were acutely aware of their lack of ability. It could be that the nature of the tasks also moderates whether and how self-efficacy beliefs relate to task performance.

To summarize, we point out that when investigating both self-efficacy and performance, four combinations are possible: A child may have a high self-efficacy score with a high performance score, a high self-efficacy score with a low performance score, a low self-efficacy with a high performance score, and a low self-

efficacy with low performance score. In this study, only the fourth combination, a low self-efficacy with a high performance task, was not evident. This is in line with previous studies, reporting that young children either correctly assess their abilities to perform or over-estimate their abilities. On the one hand, it is desirable for children to correctly estimate their abilities. A child with a high self-efficacy but a low performance may not recognize the need to expend effort in order to learn and achieve something new. On the other hand, it is possible that for very young children, it is desirable that they do not, for the most part, exhibit low self-efficacy, even when it is warranted. Young children are surrounded by tasks which, due to their age, they cannot perform. If they correctly assessed the situation, they might be driven to give up, without trying. A naïve belief in one's abilities to perform many types of tasks may be nature's way of assuring that children will strive to do new things and learn new tasks. Of course, it is the job of a caring adult to watch out for young children who believe that they can perform task that are dangerous (such as jumping off the swing without hurting themselves). But, as educators, we might take children's over-estimation of their abilities in a positive light, and encourage them to try out and learn new tasks which, with proper instruction, they can learn to accomplish.

Finally, we point out that this study was an exploration into children's self-efficacy beliefs. Based on our results we offer a tentative hypothesis: accurate self-efficacy beliefs are beginning to develop at this age and perhaps do so from extreme cases. In our study, reciting the English alphabet was such a case. It was clear to nearly all the children that they could not recite the English alphabet and almost everyone was able to state that they could not do it. From there we move to the task of identifying pentagons. Self-efficacy beliefs, although high, were lower for this task than for the comparable task of identifying triangles. This corresponded to the children's lower performance on this task than for the triangle task. We are beginning to see that children do exhibit some self-awareness and do detect a difference in their ability to perform different tasks. Other factors at this age, such as children's imagination and their different interpretations of performance, must also be considered. As Davis-Kean et al. (2008) claimed, a turning point occurs between the ages of 5 and 7 years old with regard to children's cognitive development. It seems that this study captures the beginning of this turning point with regard to children's self-efficacy beliefs.

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