THE INFLUENCE OF 'MATHEMATICALLY MINDFUL MOVEMENT' ON THE ABILITY TO UNDERSTAND CONCEPTS IN MATHEMATICS AMONG KINDERGARTEN CHILDREN

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Abstract: 'Mathematically-mindful movement', a work program in the kindergarten[1] that integrates movement and is intended for the learning of concepts in mathematics through the initiative and planning of the kindergarten teacher.

Keywords: *'Mathematically-mindful movement', learning of concepts in mathematics, kindergarten children*

"The kindergarten constitutes an important framework of learning for the child. The learning in the kindergarten is accomplished primarily in an experiential manner through songs and stories, through games of different types, in the kindergarten and outside of it. It is generally performed in an integrative manner and is based for the most part on topics from the children's world. Most of the children learn best when additional channels are used, such as the sensory

[1] In Israel the kindergarten is a framework for children aged three to six, thus including what in other countries may be called preschool and/or pre-kindergarten. In Israel the kindergarten has three levels: compulsory kindergarten for children aged five, pre-kindergarten for children aged four, and pre-pre- kindergarten for children aged three. Kindergarten attendance is not mandatory at the younger two levels. Different kindergartens will have different levels. A kindergarten may have only one grade level, or two (pre-pre-kindergarten and pre-kindergarten or pre-kindergarten and kindergarten), or even (rarely) all three.

channel and the visual channel, in addition to the verbal auditory channel." (Ministry of Education, Curriculum for Pre-Elementary Education, 2009).

In Israel there are still many teachers who continue to believe that learning occurs only when the child is quiet, calm, and attentive. In light of this situation, I see it to be important to change the thinking and assimilate the importance of the contribution of activity in movement into the learning process.

As of today, the accepted curriculum uses mathematically mindful movement in a rather limited manner. There is barely any opportunity to use mathematically mindful movement, although the awareness of the importance of movement during early childhood has increased in recent years. The Ministry of Education has given instructions and directions to begin the morning with movement, a physical education lesson, but without the context of the learning any type of theoretical material.

The entry into the school occurs in the State of Israel around the age of six. At this age, most of the children achieve the physical, social-emotional, sensory-motor, and intellective readiness that enables them to begin learning in the school, with all its implications. Sensory-motor readiness is acquired in a process of growth, which is built gradually, step after step. In every stage the activities that the child can do multiply and diversify. The repeated 'practice' establishes the sensory-motor ability and promotes the process of maturation.

The scope of the creative tasks that the child is supposed to solve during the play is broad and complex. He must find solutions, discover new ways, decipher social codes, obey the laws, and determine new laws as needed.

In the field of the mathematical processes, the PISA research addresses collections of processes and not the single process. The simplest collection is the collection of arithmetic actions. The second collection includes methods of solving familiar 'standard' problems. The third collection addresses reflective

processes related to quantitative thinking, generalizations, mathematical analyses, identification of factors in different situations, asking questions, and search for solutions (Mevarech, 2008).

The reciprocal relations of children with the environment are of great importance. Therefore, it is important that the environment change and challenge according to the children's mathematical needs. (Ministry of Education, Curriculum for the Kindergarten, 2009).

It is necessary to introduce changes in the educational system in early childhood in a number of areas.

- Change of the ways of learning. To develop a child who has the ability to understand mathematics already in the kindergarten. This is a child who learns from internal motivation and enjoyment. These ways of teaching, which were developed and attempted throughout a number of years in the kindergartens, promoted the learners' achievements and created an optimal educational climate in the kindergartens.
- Development of teaching faculty. The goal is to develop professionalism, to develop kindergarten teachers who are satisfied with their work and have a high level of motivation, kindergarten teachers who will say about themselves that they are better than they were in the past and more creative.
- Cultivation of an optimal climate. The goal is to have in the kindergarten a pleasant atmosphere and to have the children report that they love coming to the kindergarten and enjoy learning arithmetic.

Kindergarten teachers who are interested in creating a process of teaching in which the children are involved in learning, from the internal motivation and sense of enjoyment and who seek to teach children to have mathematical thinking ability, can through the model obtain tools and act according to unique ways of teaching, and this alongside the development of a professional teaching staff that

can learn to act according to the proposed principles. I am hopeful that the knowledge and educational insights that I present in this work will serve additional educational communities and provide material for thought for them.

Parents force upon their children the development of cognitive abilities too soon, to show off in front of other parents. If their child does not advance at the same level as the neighbors' children, the parents bring the child to be assessed and diagnosed for learning disabilities. Some children have been evaluated for learning disabilities already at the age of one year. The parents' expectations only increase when the child enters the first grade. I believe that the respect of the child will be expressed in sensitivity to the child's developmental needs and learning style. It is important to understand that every child is an 'excellent student'.

Children move without stop, not only when they are in the yard or during the physical education lesson but also during other learning processes in the kindergarten and in the school. The children in essence use movement for the purpose of learning. There is room to direct the children to move the body also during the studies, from the intention to exploit the advantages of movement so as to maximize the process of the theoretical learning.

'Mathematically-mindful movement' is the direction of the activity of the child in the kindergarten through body movement. This movement, intended for the learning of concepts in mathematics through the initiation and planning of the kindergarten teacher, influences the success of the studies of mathematical concepts among kindergarten children. Through clapping his hands, a number of times, the child better understands concepts such as more and less. Having the child walk forwards, backwards, and sideways will improve the child's orientation in space and make it easier for the child to understand concepts such as in 'front' and 'behind', as well as other mathematical concepts.

Already during early childhood, children in Israel are afraid of mathematics. Understanding mathematics is essential to behavior in life. Through movement and enjoyment, it is possible to cause generations of children to love mathematics and thus to improve their achievements in the field and to increase their motivation to learn.

The different issues under dispute that the researcher encountered during her work caused her to research and to understand in greater depth the contribution of the motor relationship to the readiness for mathematics. The research study examined the relationship between mathematically mindful movement and the learning of mathematical concepts and focused specifically on the relationship between learning activities that occur during movement and improvement of the achievements in the understanding of quantity and number.

The research findings prove that the kindergarten children who learn the topic of the number using the mathematically mindful movement of the body improve their learning achievements by very high percentages in comparison to children who learn in the accepted way.

There is no dispute that play and movement constitute fundamental and essential activities that are prevalent in early childhood. Much has been written on the contribution of play to the emotional and intellectual development of the child and the cultural and environmental influences on contents and meanings of play and movement.

The findings indicate that all learning activities that the children use when performing movement that serves learning of the topic of the number indeed contributes to the learning. It is important that the professional staff in the kindergarten engage the children through mathematically mindful movement so as to create for the child a productive and inviting experience that will cause him to love mathematics.

According to Vagovic (2008), shifts in content are not enough to acquire new knowledge. Therefore, it is possible to conclude that the kindergarten teachers who use activity through movement as a transition tool miss out on the idea of the break for the goal of the internalization and miss out on the advantages of learning through movement.

The conclusion is that it is necessary to address activity in movement as the learning of content, to integrate it in the curriculum, and not to use it as a game of transition.

Salomon (2002) holds that kinesthetic movement engages the cerebellum, the part of the brain responsible for movement. It enables learning beyond physical learning. Since all areas of development are interrelated and influence one another, the activity in movement influences the types of learning. According to him, activity in movement influences more than physical fitness, since all development areas – physical, social, emotional, and intellective – are related to one another and influence one another.

The research study on mathematically mindful movement proved that following the learning in movement there was a considerable improvement in the ability of understanding of the kindergarten children in the intellective field, in the understanding of the mathematical concepts. It is possible to understand from Salomon (2002) that movement enables learning in all areas of development.

The conclusion is that mathematically mindful movement influences additional aspects that were not examined in my research study, such as development in the physical, social, and emotional areas.

According to Jirsa (2004), it is possible that the fact that movement in the learning environment has not only a component of the supply of information about the information but also a component of response, which is feedback for the question of whether the information on the environment is correct. Success in the

catching of a ball confirms information on the number of times that the ball is caught. If we are helped in this process of feedback for theoretical learning, the success of the movement enables feedback on the acquired information (Radford, Demers, Guzman, & Cerulli, 2004). Activity in movement enables the kindergarten children to search for a solution while obtaining feedback from the movement itself, which enables perseverance and repeat experience. In contrast, if the kindergarten teacher wants to provide for the children many possibilities of solution, then she must focus the activity on the planned movement in a wider variety of actions (Shuval, Talmor, Garmise, 2006).

The relationship between learning in movement and the improvement in the achievements is clear and unequivocal. The children who are found in movement activity improve their achievements, while the learning of children who are found in a less active curriculum is harmed (Ellis, 2000). The results of the research on mathematically mindful movement reinforce this argument, since the children improved their achievements by tens and hundreds of percentage points relative to the control group.

The conclusion is that the learning through mathematically mindful movement is significantly correlated with the results of the scholastic achievements in mathematics. The understanding of the body and kinesthesia greatly contribute to the cognitive understanding. It is important to use the ability of the understanding of the body and to work with the child already when he is of kindergarten age as a part of the curriculum.

Today, innovative research studies are being conducted in the world in the field of brain research and have implications also in the field of education. One of the arguments is that we can train and develop the cognition and the emotion and that it is possible to work through body movement, a topic that requires change of the cognitive perception, different design and organization of the educational

environment, and adjustment of the daily agenda to the perception. However, despite the research studies in the field of education, it is still difficult to find a practical expression for these research studies. The curricula and the work have barely changed: it is as if the daily routine, the class climate, the composition of the system, the design of the physical and educational environment, and the use of teaching aids and technology have frozen.

The conclusion is that the results of the research studies enable the development of cognitive and emotional abilities based on insights from brain researches from recent years through movement and meta-cognitive strategies.

Shimoni (2006) holds that through organized and mediated movement activity the children investigate and discover the environment that is provided for them at a personal pace, improve their movement from experience in a familiar and changing environment, acquire confidence in the familiar and regular environment and thus learn to cope with new and unfamiliar situations, learn to know themselves, their physical abilities regarding the regular and changing environment, and thus acquire confidence to act from freedom of choice in a given framework (Shimoni, 2006). The research indeed confirms these data and presented considerable improvement among the children in the understanding of the mathematical concepts. There is no doubt that the infant learns naturally through movement.

The conclusion is that learning through movement is natural. Hence, learning through movement is more effective than learning through worksheets.

Cohen Zmora (2013) holds that mathematics simplifies the most basic thinking processes. A person who learns this subject learns to make accurate distinctions and to differentiate between what is important and what is not important, so that if we understood something once then it will be correct for another place at another time. I see the importance of the learning of mathematics

at the age of the kindergarten to be most important, as opposed to other subjects when the timing, which is related to the young age, is less significant. Learning through mathematically mindful movement causes the child to want to learn and to continue to learn mathematics as he experienced it during early childhood, since mathematics engages in abstract thinking and influences the child's thinking patterns for his entire life.

Mathematics is the apex of abstract thinking. It enables the world to be predicted, and thus it is useful for all. The problem with abstraction is that it needs to be learned. Abstraction is learned by explanations but through tangible experience. When we learn correctly, the satisfaction with mathematics can be considerable.

The children enjoy different movement games. The feeling of efficacy is pleasant for them. The sense of ability increases when they achieve mastery of the performance of the game task. The enjoyment of children increases when they perform a more difficult task and they meet its requirements. The level of play increases as the child grows older and the level of satisfaction and enjoyment change accordingly. During the process, the children cooperated fully and responded to the planned movement and social learning activities.

The conclusion is that the process of learning through mathematically mindful learning resulted in satisfaction, enjoyment, and sense of efficacy. Because of the feeling of efficacy, additional goals were achieved, and enjoyment was caused, which caused perseverance in activity.

Movement that is subject to learning tasks enables a long stay in the task from the following reasons. It maintains dialogue between internal processes that cope with the question and external processes, in which the children move and which enable feedback and causes the continuation of the activity (Shuval, 2003).

The conclusion is that the great response of children to the movement during learning derives from the enjoyment and arousal. Activity in movement encourages and motivates children to attempt again and again and to remain a considerable amount of time in the learning process.

The learning of mathematics through enjoyment is a 'profitable investment' in the child's future. The building of a relationship between mathematics and enjoyment will serve as a platform for the continuation of jumps to other subjects. During the kindergarten teachers' participation in in-service training, they described active and increased participation of the children in learning activities related to 'mathematically mindful movement'. They reported that the children responded and waited for planned movement and social learning activities.

The conclusion is that learning that integrates movement will influence the learners' feeling of enjoyment

When meeting all together, with all the children of the kindergarten, the kindergarten teacher does not have the possibility of following up after the processes of learning of each and every one of the kindergarten children. During the verbal meeting, the kindergarten teacher gathers and examines the internalization of the knowledge of the kindergarten children in a personal manner, a process that takes considerable time.

The conclusion is that the activities in 'mathematically mindful movement' have an advantage over the verbal meeting / the meeting together, since in movement activity the activity occurs all at one time.

This conduct helps the kindergarten teacher follow up during the learning time after the processes of learning in actuality of the individual and the group and obtain considerable and rapid information.

The kindergarten teachers who participated in the mathematically mindful movement in-service training course reported that as the kindergarten children spent more time in this activity their degree of participation in and enthusiasm with the learning of mathematics increased, benefitting the internalization of the material.

Jensen (2004) adds that for activity in movement to engage the brain and encourage learning it needs to be innovative, challenging, unthreatening, and emotionally inspiring. In other words, the activity needs to be suited to the child's age and to engage in the solving of problems, involve the child, and awaken in him a variety of emotions as well as enthusiasm and happiness.

The activities in mathematically mindful movement are age-appropriate and challenge the children in the kindergartens. However, it is possible that the very participation in the research study, the holding of in-service training courses, the close accompaniment of the researcher, the discourse created among the kindergarten teachers, the increasing belief in the process following the success – all caused the very strong motivation among the kindergarten teachers. The conduct around the topic, which caused high awareness of the kindergarten teachers, may explain part of the high achievements of the research participants.

Kavelson (2009) addresses the questions and raises wonderings pertaining to the relationship between play, movement, development, and learning. The research results indicate clearly that children learn, develop, and improve their ability to understand mathematical concepts through mathematically mindful movement. In this time period, when children move around less, there is considerable place for motor-cognitive activity in the kindergarten framework. The learning during the play and mathematically mindful movement causes the children to feel a sense of confidence and enjoyment and improves their success. The educator must mediate and stimulate the child to act, so as to encourage him

to stay in activity for a continuous time, as he will be interested and will act more, his chance to improve his abilities increases.

The accepted way of the kindergarten teacher to examine learning during its occurrence in the classroom is the management of verbal interaction in which children have the opportunity to undergo processes of learning and to present what they learn. This process is limited, from the technical reasons, since when one learner speaks, the others are supposed to be silent, so that his words will be heard. The collection of information on the learning processes of the kindergarten children in a verbal manner is slow. This reason justifies the help of additional professionals in external and explicit activities, which can occur simultaneously and help the kindergarten teacher follow up during the learning time after the learning processes in actuality, which was not taken into account in this research study.

Education during early childhood developed in the past decade in an accelerated manner in the world in general and in Israel in particular. However, a theory has not yet been developed and a research had not yet been performed on the following question. What are the learning activities that occur during the body movements that improve the success of the mathematical understanding?

The researcher found in this research study that there is a high correlation between mathematically mindful movement and the understanding of concepts in mathematics. As the child's verbal language is more limited (for example, new immigrants, immigrant children), the influence of the mathematically mindful movement will be expressed more.

The research shows that the child who participates in a learning activity of mathematically mindful movement can surmount his low starting point. The findings indicate that learning activities performed by children through movement serve and contribute to the learning of the topic of quantity and number.

The achievements of children from pre-pre-kindergarten (preschool) were identical to those of the children from pre-kindergarten, during the performance of an intervention of only half a year. The children of the experimental group passed the children of the control group by half a year and even more.

The findings of the research study indicate the fact that the kindergarten children who learn the topic of quantity and number through body movements improve their learning achievements more than do children who learn in the conventional manner.

In this research study, through 'mathematically mindful movement' the experimental group reached in half a year the same and even higher achievements than did the control group, which required a full year. The research study proves that aside from the enjoyment and positive experience from mathematics the learning through mathematically mindful movement improves the mathematical understanding among the kindergarten children.

Significant differences were found in the influence of the learning through mathematically mindful movement on children from different social frameworks. There was a meteoric improvement among boys and girls from the Ethiopian community, and it is possible that the improvement derives from their low initial level.

The mathematically mindful movement improved differently the achievements of the boys as opposed to the girls. It was found that the gap in mathematics begins already at the age of the kindergarten.

In early childhood, age three, the girls achieved better results than did the boys, by a small difference. At the age of four-five the trend was reversed, in favor of the boys. Differences were found between boys and girls from different social frameworks. It is possible to determine that girls aged three-four in the

Arab and Ethiopian population attained significantly higher achievements than did the boys after the intervention with mathematically mindful movement.

In the Jewish population, the improvement of the achievements was prominent in favor of the boys relative to the girls already from the age of three-four after the intervention program. In addition, among children aged five in the Arab and Ethiopian population the boys attained significantly higher achievements than did the girls after the mathematically mindful intervention. In the Jewish population, the boys reached higher achievements but not with a significant gap.

There is a difference in the influence of the learning through mathematically mindful movement on the improvement of the mathematical abilities of children in the pre-pre-kindergarten (preschool) and the pre-kindergarten as opposed to the children of compulsory kindergarten. The mathematically mindful movement influences at higher percentages as the learner is younger in age.

It was found that young children aged four who are educated in a multi-age kindergarten benefit differently if they are in the company of younger children or older children. The research study proves that children aged four who learned with children who are older than they are attained achievements 60% higher in the test before the intervention and attained results 28% higher in the test after the intervention, in comparison to children aged four who were educated in the kindergarten with children younger than they are.

Mathematically mindful movement contributes to the learning of mathematical concepts in entwined ways. Mathematically mindful movement implements the kinesthetic perception that constitutes a significant channel for the processing of information for learning, creates conditions for learning through the delay of the body movement, encourages perseverance in learning, facilitates the

transition of intuitive information to formal knowledge, and enables opportunities for independent learning. In my research study, the children experienced the learning of mathematics through mathematically mindful movement, a means that simplifies the learning, makes it experiential, and causes the child great satisfaction.

From the findings it is possible to say that as the learner used more greatly the learning actions during movement, his learning achievements were higher.

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