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Ph.D. Summary

PHYSICAL ACTIVITY BASED ON ESHKOL-WACHMAN MOVEMENT NOTATION IMPROVING GEOMETRY STUDIES FOR 3rd AND 4th GRADE PUPILS

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2015

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List of abbreviations

EWMN - Eshkol-Wachman Movement Notation
PA - Physical Activity

INTRODUCTION

The present study explored an intervention program which integrated physical activity (PA) through Eshkol-Wachman Movement Notation (EWMN) with theoretical learning at primary school. This was a field research designed to improve primary school pupils' attainments in and attitude towards a theoretical subject in geometry. The present study originated in the need to examine whether this program is suitable for incorporation within the curricula prevalent today with the purpose of improving and rationalizing them. Moreover, it aimed to deepen and enrich the knowledge and understanding of the researching teacher.

The effectiveness of the intervention program was checked by comparing two experiment groups with two control groups. The experiment groups learnt the topics of angles and symmetries through the intervention program described in part II and the two control groups learnt the topics in the customary way which combines teachers' frontal explanation and exercising with the aid of a textbook.

The present study explored whether bodily movement, in addition to its considerable importance for the motor development of children, could benefit their theoretical learning since children learn about the world by being aware of bodily movement (Shaw, 1990). PA through EWMN combines cognitive, descriptive, logical, deductive and rules-oriented thinking.

EWMN is a language based on an analytical method which defines the units necessary for describing human body movement in space and time. The description is done in relation to a geographic-spherical system of reference and is written on a special text page representing the body structure (Eshkol & Harries, 2000).

The uniqueness of teaching through EWMN is the fact that its comprehension is translated into a visual experience. Learning is experiential – through movement – and formal – through directed and defined rules (Sapir & Blum, 2002). EWMN is universal and can be taught by every teacher who has specialized in it.

Research objectives

- Implementing an intervention program, using PA through EWMN, in teaching two geometry topics: angles and reflection and rotational symmetry.

- Examining the effect of the intervention program, based on PA through EWMN on learning two geometry topics: angles and reflection and rotational symmetry.

Two sub-objectives

- Examining whether learning by means of PA through EWMN will improve knowledge of angles and reflection and rotational symmetry.

- Examining whether learning by means of PA through EWMN will improve primary school pupils' attitude towards geometry.

Research questions

- Will the intervention program, using PA through EWMN, improve 3rd and 4th grade pupils' level of knowledge in geometry in relation to frontal teaching in class?

- Will the intervention program, using PA through EWMN, improve 3rd and 4th grade pupils' attitude towards geometry in relation to frontal teaching in class?

Research hypotheses

- The intervention program, using PA through EWMN, will improve the level of knowledge of 3rd grade pupils in the topic of angles and that of 4th grade pupils in the topic of reflection and rotational symmetry, in relation to frontal teaching in class.

- The intervention program by means of PA through EWMN, teaching in the 3rd grade the topic of angles and in the 4th grade the topic of reflection and rotational symmetry, will improve the pupils' attitude towards arithmetic and geometry, in relation to frontal teaching in class.

The importance of the present study resides in the integration of PA through EWMN with an in-depth understanding of a learning topic in class, by means of a learning and teaching method in addition to the one prevalent today. The contribution of the present study is the combination of EWMN as part of the teaching options available to teachers (provided they are familiar with EWMN). Furthermore, using the method of movement proposed by the present study will satisfy to a greater extent children's need for moving their bodies while they are at school.

Part I. LITERATURE REVIEW

THEORETICAL BACKGROUND

This section reviews the two disciplines on which the present study is based: PA through EWMN and geometry teaching at primary school.

"Movement is the door to learning" (Dennison, in Hanford, 2002, p. 99).

Movement inside the womb gives us the first sensation of the world and the beginning of our experience and knowledge of the laws of gravity. Each movement is a sensory-motor event associated with comprehension of the physical world, the world from which every new learning experience is derived. Movement stimulates and activates many of our mental capabilities. It combines and sets down information in our nervous system and is essential to all the actions by means of which we embody and express learning, understanding and ourselves (Hanford, 2002).

The present study investigated the effect of the intervention program based on EWMN integrated with cognitive learning of two theoretical geometry topics, angles and symmetries, included in the formal curriculum of the Israeli Ministry of Education for pupils in the 3rd and 4th grades. This enables learning through PA by means of EWMN. See figure 1.

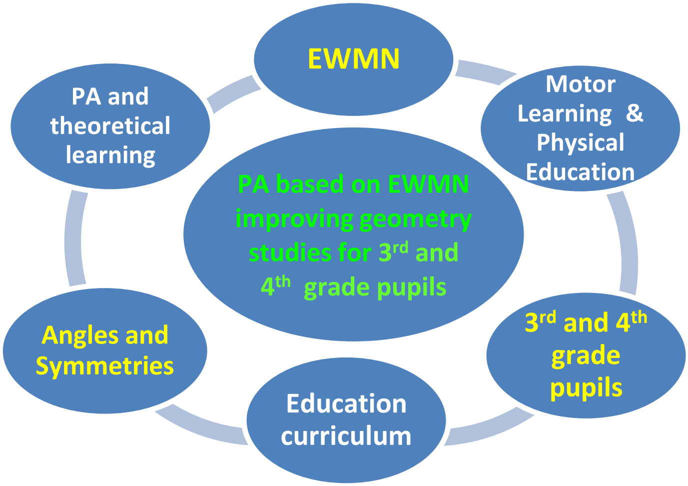


Figure 1: Main theories

Eshkol-Wachman Movement Notation

Eshkol-Wachman Movement Notation (EWMN), which is the basis of the present study, was conceived in Israel and published for the first time in 1958 by the late Prof. Noa Eshkol and the late Prof. Avraham Wachman (Eshkol & Wachman, 1958). It is one of the four international movement notations known today: Benesh, CMDN (Chinese movement notation), Laban and Eshkol-Wachman Movement Notation. Today, EWMN is studied in several primary schools in Israel.

As its name implies, EWMN notation is a way of writing movement, similar to writing musical notes. The notation signs consist of digits, letters and graphic signs, whose varied combinations can describe directions, paths and any other visible movement event. (Eshkol & Wachman, 1998, 2000).

Integrating PA through EWMN in learning depends on teachers' approach and willingness to create a stimulating environment for action in an open and supportive learning atmosphere. Jensen (2003) argues that for pupils, learning which integrates physical practice is easier to master, is better remembered, and mostly creates positive experiences which might be internalized and recalled for a long time. This is applied learning which provides great sensory input to the brain. Thus, by performing PA through EWMN assignments, pupils can express in an active, non-verbal manner the understanding of familiar or new learning material.

In order to create a meaningful learning experience, pupils should be allowed to study in their own unique way which is related to their characteristics as well as to the intelligences with which they are endowed (Cohen, 2007). When such active learning is supported by a positive atmosphere and by setting a motor and cognitive challenge, pupils' internal motivation is reinforced, creating a sense of inner reward (Segev-Tal & Galili, 2010).

According to the Multiple Intelligences Theory conceived by Gardner (1996), we can analyze the place of the bodily-kinesthetic intelligence in learning and explore options for combining this intelligence with the other intelligences in order to corroborate the contribution of integrating PA through EWMN in teaching.

When combined with theoretical learning, PA constitutes, at the preparatory stage of learning, an exercise of delayed PA which does not mean lack of PA but control over the PA and preparation for the learning focus (Shoval, 2009).

In addition, the psychomotor approach points out the importance of integrating cognitive, emotional and social aspects and motor performance (Walter, 2014).

Mediated Learning Theory (Feuerstein, 1998), emphasizes the importance of education in creating the intelligence. Integrating EWMN in theoretical learning serves bodily-kinesthetic learning, logical-mathematical learning and spatial orientation and it is meaningful to pupils endowed with these intelligences. EWMN enables data structuring: close guidance towards a clear objective, sequence learning, building PA through EWMN structures, and receiving feedback on accumulated knowledge. The learning is active, systematic, directed and adapted to pupils' level of knowledge. Thus we can see that the theories conceived by Gardner and Feuerstein support the intervention program based on EWMN which is explored in the present study.

Physical activity through Eshkol-Wachman Movement Notation

EWMN enables PA through EWMN activities and experiences which, by their very nature, engage in visual perception and spatial-kinesthetic perception as well as in graphomotor functions and motor-visual coordination.

The principles of EWMN can be used to disassemble bodily movement events into basic components and to symbolize these events in a limited system of agreed symbols. This facilitates a fruitful relation between PA through EWMN and core skills of formal learning (reading, writing, arithmetic) (Sapir & Blum, 2002).

Below are the two principles of EWMN which underpinned the intervention program:

1) The PA through EWMN of the body parts is circular.

Every part of the human body has a circular physical movement from the joint to which it is connected. From any axis of a body part we can form a circle or part thereof. The PA through EWMN of every axis of a body part forms an angle in relation to the adjacent part. Consequently, the topic of angles as part of a circle can be illustrated, understood, and organically and naturally linked to PA through EWMN lessons (Figure 2).

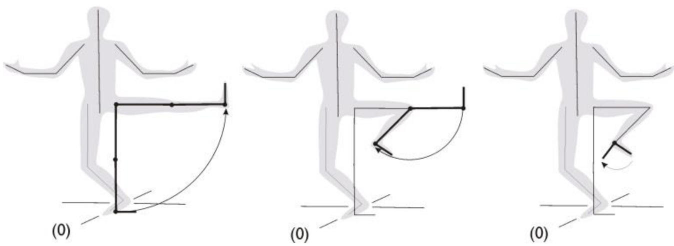


Figure 2: Every axis of a body part forms an angle in relation to the adjacent part (Harries & Sapir, in press)

A circle can be divided in different ways. In the division chosen for the intervention program of the present study, one circle has 8 parts. Each part equals 45° and is referred to as one quantity (Figure 3).

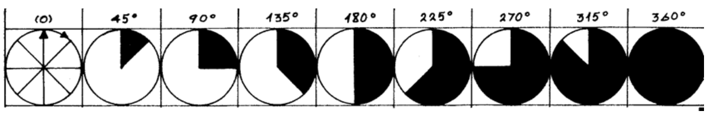


Figure 3: Movement quantity in EWMN (Eshkol & Shoshani, 1982)

2) The system of reference of EWMN.

This is a spherical system which exists in every joint. Body parts (joints) are simulated as straight lines moving inside a sphere and therefore, their PA through EWMN is circular. Space is divided into latitude lines - horizontal - and longitude lines - vertical - which together create a spherical system of reference. Thus every body part, wherever it is located, is defined by a longitude line and a latitude line known as a position. The positions and PA through EWMN of the body parts can be notated on a special manuscript page which is adapted to the structure of the human body (Figure 4).

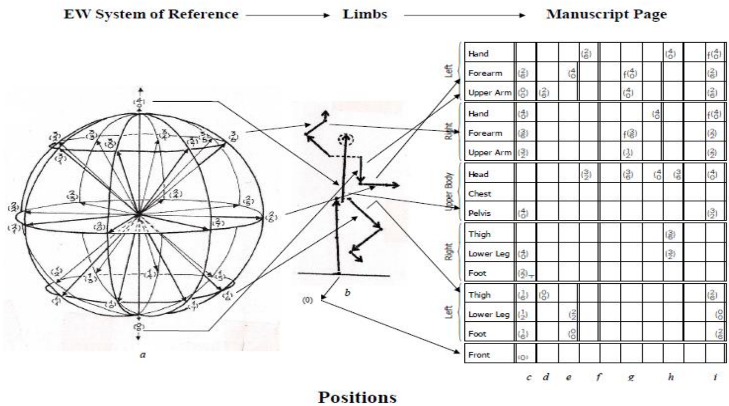


Figure 4: EWMN spherical system of reference, its connection to the human body, and according to the manuscript page (Harries & Sapir, 2009)

The relation between physical activity and arithmetic and geometry

"The closer you look at the brain-body mutual activity, the more you realize that movement is essential for learning" (Hanford, 2002, p. 99).

Physical-kinesthetic intelligence enables a movement which is part of any activity we perform. Consequently, it can be integrated with skills of spatial intelligence and logical mathematical intelligence in order to improve the pupils' theoretical learning (Shoval, 2006). The relation between spatial intelligence and logical-mathematical intelligence is in line with Fadalon & Patkin (2000) who maintain that our world is basically geometric and that spatial perception is needed for understanding it. Developing spatial perception and spatial skills is a practical and useful goal. Using spatial intelligence was found as highly crucial for the development and enhancement of mathematical thinking competences of young children (Fadalon & Patkin, 2000).

Furthermore, the physical education curriculum in Israel (Ministry of Education, 2006) recommends integrating the PA with the theoretical subjects studied at school. This is based on the acknowledgement of physical learning as experiential, illustrative and suitable to every pupil.

In light of the recommendation of the Professional Standards for Teaching Mathematics (National Council of Teaching of Mathematics, 1989), we have to choose a teaching method which will encourage pupils to understand rather than memorize the learnt material. A mindful movement (Shoval, 2009) underscores comprehension by means of the body movement which is in fact PA through EWMN.

Implementation of mathematical activity and movement in space requires a visual expression of thinking and calculating. During the PA the pupils discuss the mathematical activity and the discourse between them offers an opportunity for immediate control of the learning. Pupils apply here a non-verbal thinking which is based on visual impression. This is thinking at an initial level which is connected to geometric thinking according to Van Hiele's theory of developing geometric thinking levels (Segev-Tal & Galili, 2010).

Angles and symmetries

The two theoretical topics, angles and symmetries, were chosen for the present study following studies and teachers' reports about the difficulties pupils encountered in the internalization of these theoretical topics included in the formal curriculum of the Israeli Ministry of Education for 3rd and 4th grade pupils.

The topics of angles and symmetries are supported by EWMN, which symbolizes and draws the cyclic movement of body parts by means of a spherical system of reference. Moreover, it enables both abstract and practical observation which activates thinking and enriches knowledge.

During PA through EWMN, the pupils comprehend the topics of angles and symmetries by writing, reading and PA through EWMN.

Angles

An angle has a vertex from which two lines called rays are pointing. The length of the rays does not change the angle and has no effect on its size. Thus, every joint in the body is a vertex of an angle and the adjacent joints are its rays regardless of their length.

Below is an example of PA through EWMN teaching taken from an EWMN lesson on the topic of angles: Perform with the right arm – upper arm, forearm and hand – the three angle types. Write the angles in the following table – in words, by drawing the angle shape, in angle degrees and in EWMN.

Table No. 1: An example of movement teaching taken from Eshkol-Wachman Movement Notation lesson on the topic of angles

	Angle name	Angle drawing	Degrees	Position in EWMN
Right hand	Obtuse		135 between the hand and the forearm	$\binom{4}{2}$
Right forearm	Acute		45 between the forearm and the upper arm	$\binom{5}{2}$
Right upper arm	Straight		90 between the upper arm and the torso	$\binom{2}{2}$

Figure 5: A pupil performing the three angle types with his right arm

Symmetries

The geometric basis of EWMN, and consolidation of its components into a coherent system with rules and regulations of its own, link the world of PA through EWMN to systems of concepts and symbols which are studied at school. For example, reflection and rotational symmetries which can be defined by the system of reference.

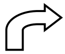
Reflection symmetry is a copy of the plane, defined by means of a straight line on the plane. Thus, each point on the plane is copied to a point on the other side of the straight line and at the same distance from it.

Rotational symmetry occurs when the center of the symmetry is such a point that a rotation smaller than a full rotation around it copies the shape on itself.

The natural given of extremities in the human body, two legs and two arms and the ability to move them, enables a view of rotational and reflection symmetry. The ability to advance in space while noticing the course of progress of the group, in each of the symmetry types, allows additional illustration of the topic and the understanding thereof.

Based on the spatial division of EWMN, PA through EWMN of body parts in the two symmetry types can be examined.

Reflection symmetry

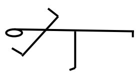


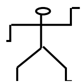
Rotational symmetry

Figure 6: Reflection & Rotational symmetry

Below is an example of PA through EWMN teaching taken from EWMN lesson on the topic of symmetries: Write in the following table, for each of the figures, the type of symmetry it presents and the position of the arms in EWMN, and perform it with your body.

Table No. 2: An example of movement teaching taken from Eshkol-Wachman Movement Notation lesson on the topic of symmetries





	1		2	
Figure	Position	Symmetry type	Position	Symmetry type
Left hand	$\binom{3}{6}$	Reflection	$\binom{2}{6}$	Rotation
Left Forearm	$\binom{1}{6}$	Reflection	$\binom{0}{0}$	Rotation
Left upper arm	$\binom{1}{6}$	Reflection	$\binom{2}{6}$	Reflection
Right hand	$\binom{5}{2}$	Reflection	$\binom{2}{2}$	Rotation
Right forearm	$\binom{3}{2}$	Reflection	$\binom{4}{0}$	Rotation
Right upper arm	$\binom{3}{2}$	Reflection	$\binom{2}{2}$	Reflection

Part II. THE INTEGRATION OF THEORY AND PRACTICE

THE INTERVENTION PROGRAM

The intervention program integrated EWMN with two geometry topics taken from the primary school curriculum: angles and symmetries and was implemented for three years. During that period, all the participants read, wrote and moved according to EWMN as a basis for learning the movement language and its integration with theoretical subjects.

Below are the three stages of the intervention program:

Stage 1: Learning the language of EWMN.

The EWMN curriculum is grounded in topics which are associated with space, time and human body parts. Every lesson is based on the knowledge acquired in previous lessons which is then enhanced with additional knowledge according to the pupils' age level. Reading, writing and manuscript pages are all familiar to school pupils. Creative bodily movement is based on human body movement both in space and in time and this combination enables knowledge, awareness, motivation and pleasure. In EWMN the learning through movement is conscious, controllable and measureable.

Stage 2: Integrating the language of EWMN with theoretical learning topics.

Based on the knowledge of EWMN, the pupils experienced integrating EWMN into theoretical learning topics such as geography (compass directions), arithmetic (deduction, addition, multiplication and division), and sciences (human body structure). These programs were developed by Ms. Tirza Sapir, Head of the Institute for the Research of Movement Languages at the Kibbutzim College of Education in Tel Aviv, but have not yet been investigated in any empirical research.

Stage 3: Integrating the language of EWMN with the topic of angles and the topic of symmetries.

During the third stage, the researcher explored the integration of PA through EWMN with the topic of angles and the topic of symmetries as part of the intervention program which relies on the pupils' previous knowledge of EWMN. Each geometry topic is based on a certain level of knowledge of EWMN. The movement lessons are adapted to and include all the required contents of the Israeli Ministry of Education curriculum in the series *Simply Arithmetic* (Ministry of Education, 2008).

In EWMN movement lessons, pupils learn concepts in geometry which are included in the curriculum textbooks dealing with angles and symmetries. The movement lessons (given to the experiment groups in the movement room) correspond to the lessons in the regular classroom (for the control groups).

Every lesson combines creative movement associated with the lesson objective, the mindful movement dictated and defined by the teachers, and the reading and writing of movement from the EWMN manuscript page. Every lesson is based on the material studied in the previous lesson, bringing in something new from the subject studied.

In every lesson there is an interaction between the pupils, manifested by joint writing and/or reading, by exchange of written pages, or by presentation of a movement exercise composed by the pupils and performed in front of the class. In the latter, the observing pupils also participate in the learning. They watch the presentation, identify the movement chosen, and are involved in the learning discourse. Thus, teachers can monitor the understanding of the pupils who composed the exercise as well as that of the observing pupils.

The third stage was conducted as a pilot study during the second semester of 2012 and was investigated in the present study during the first semester of 2013.

Part III. ORGANIZATION OF THE RESEARCH METHODOLOGY

The research was conducted according to a mixed methods approach. Thus, data collection and analysis were performed both according to quantitative-positivist research with an experimental setup and according to qualitative-constructivist research, including action research. The research design is presented in table No. 3.

Table No. 3: Description of the research design

Stage		Research Tools	Research population
1	Pilot study	Knowledge test	10 participants
		Attitudes questionnaire	
2	Quantitative research	Knowledge test	121 participants
		Attitudes questionnaire	112 participants
3	Intervention program		62 participants
4	Quantitative research	Knowledge test	121 participants
		Attitudes questionnaire	112 participants
	Qualitative research	Structured interviews	18 participants

Research population

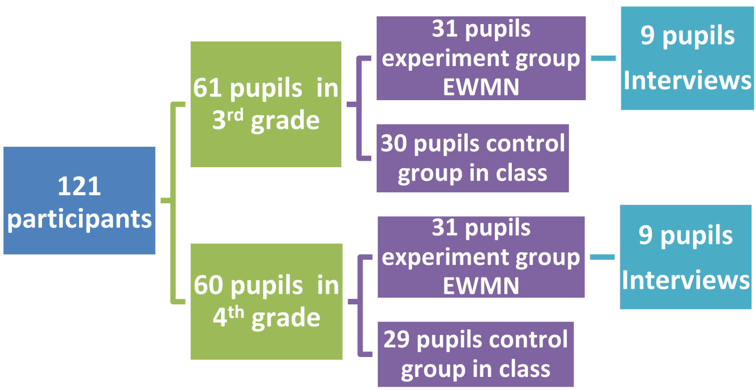


Figure 7: Research population

The participants were 121 pupils from the 3rd and 4th grades; approximately 30 pupils aged 9-10 in every class, a total of 4 classes, who learnt EWMN from the 1st to the 3rd grade. Each class included boys and girls from an average socio-economic background.

Two classes were chosen at random as experiment groups and two as control groups. The lessons of the experiment groups were taught by the EWMN movement teacher and took place in the movement room with half of the class pupils. These pupils did not learn the topics with their class teacher.

Research tools and data analysis method

The present study ~~is~~ was a mixed methods research, combining both quantitative and qualitative approaches and used three research tools.

The quantitative research tool was spread over two points in time: before and after the experiment. It included two close-ended questionnaires: a knowledge test questionnaire and attitudes towards geometry questionnaire.

The Knowledge Test of the Israeli Ministry of Education investigates the 3rd graders' knowledge of angles and the 4th graders' knowledge of reflection and rotational symmetry, according to the level of knowledge required at the learning stage of the 3rd and 4th grades.

The Math Attitudes Scale Questionnaire (Aiken & Dreger, 1961), examines pupils' attitude towards arithmetic and geometry. The questionnaire reliability, according to Ben-Yehuda (1994), was 0.94 and it was translated into Hebrew. It was applied in a study conducted within the framework of M.A. studies at the

Faculty of Humanities, Tel Aviv University (Ben-Yehuda, 1994). The present study conducted a pilot study of this questionnaire.

Findings from the questionnaires enabled a statistical analysis and provided reliable answers for the present study.

The qualitative research tool consisted of systematic interviews with 18 pupils (nine 3rd graders and nine 4th graders) following the experiment and it was measured by means of content analysis. The interviews were structured with six open-ended questions about-the process and enabled the pupils to voice their opinions and feelings freely.

FINDINGS

The research findings were analyzed in order to check the research questions and research hypotheses by means of three research tools: two quantitative and one qualitative. Research hypothesis No. 1 was investigated by a quantitative research tool and No. 2 by one quantitative and one qualitative research tool.

Quantitative Findings

Table No. 4: Means and standard deviations in the Knowledge Test following the present study in the 3rd grade and 4th grade in both the experiment and control groups

3rd grade					
C N=30		E N=31		Total N=61	
M	Std	M	Std	M	Std
64.07	24.10	79.16	25.44	71.74	25.73
4th grade					
C N=29		E N=31		Total N=60	
M	Std	M	Std	M	Std
56.79	14.00	64.68	16.74	60.87	15.85
Total					
C N=59		E N=62		Total N=121	
M	Std	M	Std	M	Std
60.49	19.96	71.92	22.57	66.35	22.06

Figure 8 illustrates a difference in the achievements of the different affiliation groups (regardless of the grade - 3rd or 4th). The experiment group scored significantly higher (M=71.92; Std =22.57) than the control group (M=60.49; Std =19.96). This difference was on a significance level of $P<0.05$ ($F(1,117) = 9.31$, $P<0.05$).

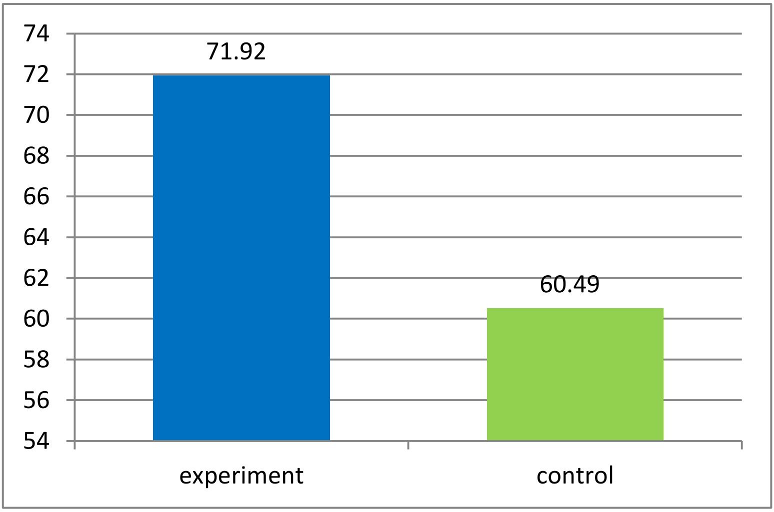


Figure 8: The difference in scores between the experiment and control groups

Table No. 5 presents the means and standard deviations in the questionnaire checking the pupils' attitude towards arithmetic and geometry.

Table No. 5: Means and standard deviations for pre-study and post-study Attitudes Questionnaire in the 3rd grade and 4th grade in both the experiment and control groups

3rd grade						
	C N=27		E N=28		Total N=55	
	M	Std	M	Std	M	Std
Pre-study	3.13	1.12	3.37	0.95	3.25	1.03
Post-study	3.43	1.15	3.51	0.95	3.47	1.04
4th grade						
	C N=29		E N=28		Total N=57	
	M	Std	M	Std	M	Std
Pre-study	3.09	0.81	3.36	1.00	3.23	0.91
Post-study	3.08	0.93	3.34	0.87	3.21	0.90
Total						
	C N=56		E N=56		Total N=112	
	M	Std	M	Std	M	Std
Pre-study	3.11	0.95	3.36	0.97	3.24	0.99
Post-study	3.25	1.04	3.43	0.91	3.34	0.96

To sum up, the quantitative research tools indicate that research hypothesis No. 1 was corroborated. Regardless of the grade, the pupils who studied by means of PA through EWMN scored better than those who did not study in this way. Contrary to research hypothesis No. 2, there was no change in the pupils' attitude towards geometry prior to and following the study.

Qualitative Findings

The qualitative part of the present study consisted of 18 interviews which were then content analyzed. Figure 9 illustrates the hierarchy of the central theme; **PA through EWMN promotes learning of the topic of angles and the topic of symmetries**, connecting the eight categories and sub-categories illustrated by the findings.

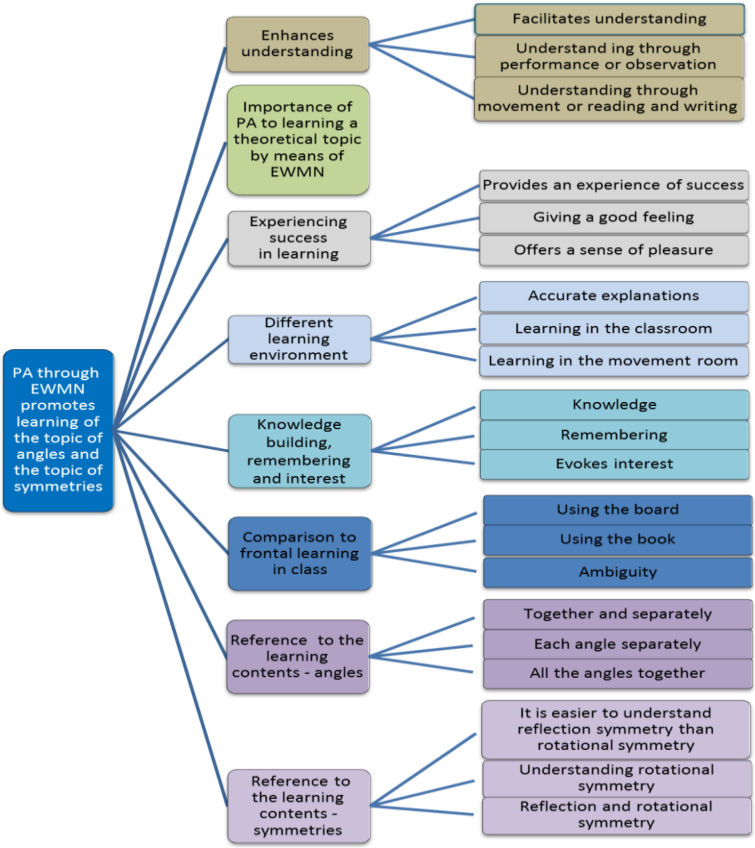


Figure 9: Presentation of the categories and sub-categories emerging from the qualitative findings

Figure 10 shows the six categories and the number of assertions per sub-category of each category, stated by the pupils in the interviews conducted following the intervention. The two additional categories relate to each pupil's individual comprehension and therefore they were not classified in this figure.

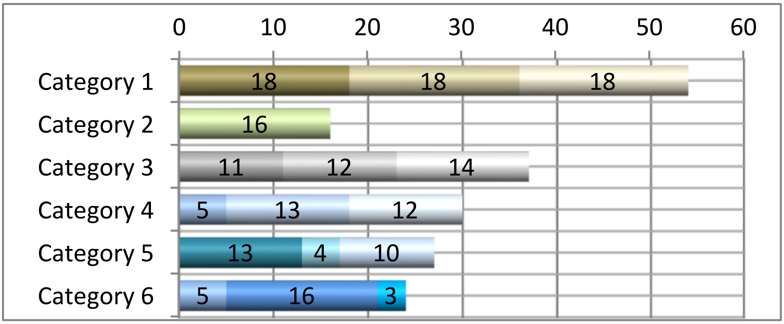


Figure 10: The number of assertions for each sub-category of each category

Summary of the findings

Below are the integrative findings which emerged from the quantitative and qualitative research tools.

Findings of the quantitative research tools:

1. The pupils who learnt by means of PA through EWMN attained better achievements than those who did not learn in this way, regardless of their grade (3^{rd} or 4^{th}).

2. The findings of the quantitative research do not indicate a change in pupils' attitude towards geometry between the pre-study and post-study measurements.

Conversely, the quantitative research tools illustrated the findings specified below.

Findings of the qualitative research tools:

3. The findings show that the intervention program by means of PA through EWMN is perceived as enhancing understanding of theoretical material such as angles and symmetries.

4. PA is perceived as important for the learning of a theoretical topic.

5. The intervention program by means of PA through EWMN offers an experience of success in learning, a positive feeling, and pleasure.

6. The intervention program by means of PA through EWMN creates a learning environment which is different from the environment prevalent today.

7. Accurate explanations are derived from the language of EWMN and relate to body movement in connection with the learnt theoretical topic.

8. The intervention program by means of PA through EWMN allows immediate control of learning.

9. In spite of the difficulty to understand rotational symmetry in relation to reflection symmetry, learning through PA by means of EWMN is important for learning a theoretical topic.

10. The intervention program by means of PA through EWMN allows learning out of interest and enables the pupils to use their own style of learning a theoretical topic such as angles and symmetries.

The integrative findings obtained by the quantitative and qualitative research tools indicate that the research hypotheses were corroborated. The pupils who studied by PA through EWMN scored better than those who did not learn by means of EWMN. Moreover, the findings illustrate that the intervention program enhanced the pupils' attitude towards the subjects of arithmetic and geometry.

CONCLUSIONS

The factual conclusions indicate that the intervention program by PA through Eshkol-Washman Movement Notation (EWMN) enables integration of theoretical subjects learnt at school with topics studied by EWMN. Moreover, it leads to higher scores and positive attitude towards the studied theoretical subjects.

The research findings illustrate that learning by PA through EWMN facilitates comprehension of the learnt materials, e.g. angles and symmetries. Furthermore, it allows pupils to understand the topics through active learning and under the guidance of an adult. In addition, learning these two topics through EWMN evoked pleasure, a good feeling, and a successful understanding of the topics. The visual opportunity provided by movement offers the ability to understand through self-performance and/or observation of another pupil's movement. It also inculcates the ability to express comprehension by means of bodily movement in an open space, providing learning in an environment which is different from the one prevalent at present.

The research findings also show that bodily movement and theoretical learning are characterized by thinking; thus it is important and possible to integrate them. The experience of movement by PA through EWMN combines cognitive, theoretical, logical, and deductive thinking as well as thinking which acknowledges the importance of rigor. Learning by means of PA through EWMN is built on explanation by stages and serves as a tool which enables meaningful occurrences in the learning. Furthermore, learning through EWMN allows pupils to demonstrate their comprehension of the learning materials and their ability to apply the knowledge they have acquired by designing creative and informed movement exercises. Hence, at any given moment, teachers can see the degree to which every pupil understands the learning material.

Conceptual conclusions

At the conceptual level, the research findings allow the presentation of a model of theoretical learning by PA through EWMN. This model is shown from three aspects as specified, presented and explained by figure 11.

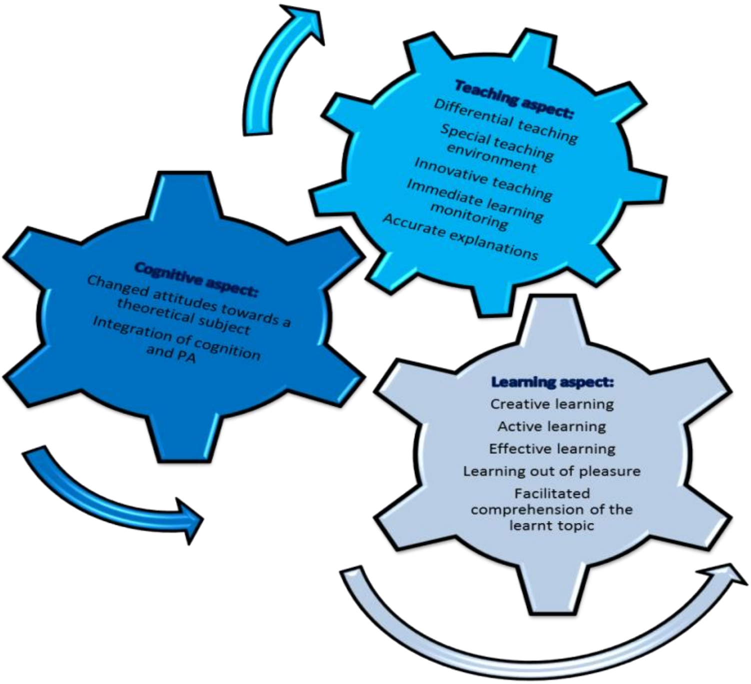


Figure 11: An interdisciplinary model: PA & Learning Theoretical Topics through EWMN

The model illustrates three aspects from three points of view (the teacher, the pupil and cognitive perception) which become possible by the implementation of PA through EWMN. This is an interdisciplinary learning model which is based on and integrates three areas of knowledge: PA, EWMN and two theoretical topics (angles and symmetries). Each area of knowledge maintains its uniqueness and their integration, as illustrated in the model, is manifested by teachers' options in teaching, pupils' options in learning and the possibility of innovative cognitive perception.

The present study investigated for the first time in an empirical manner the effectiveness of integrating EWMN with a theoretical topic. The research findings indicate that EWMN is a tool whose principles and subject matter allow its integration with a theoretical topic, leading to the originality and innovativeness of the present study.

Practical implications

The model proposed in the present study offers a new view on a theoretical topic: teaching which can be implemented not only from the textbook, sitting on a chair next to a desk in a closed classroom. Rather, it breaks down the classroom boundaries, allowing pupils to move in space and to develop intellectually in this way too.

The proposed model can constitute an independent learning unit. Consequently, it is recommended introducing the proposed model, as a learning unit, into the curriculum of primary schools in Israel. The learning unit will include teaching the topic of angles and the topic of symmetries to 3^{rd} and 4^{th} grade pupils together with PA through EWMN. This unit will be taught by teachers who are acquainted with EWMN.

It is possible to interest frameworks that engage in teachers' professional development in organizing in-service training courses of geometry at primary schools. These courses will embody the research findings with the purpose of integrating PA through EWMN and theoretical learning of the two investigated topics. This applies mainly to teachers who have no PA teaching experience.

The PATT model through EWMN combines areas of theoretical learning with PA. Thus, we can integrate physical education teachers in professional development frameworks for theoretical topics teachers, facilitating an interdisciplinary development at school.

Contribution to knowledge

The contribution of the present study to **theoretical knowledge** resides in the fact that this is the first study to explore the integration of PA through EWMN and a theoretical topic. The theoretical contribution of the study facilitates the understanding that the theoretical topic can be taught by PA through EWMN. An active and personal knowledge structuring through EWMN movement language highlights and emphasizes the importance of active learners. Thus, all teachers who are familiar with EWMN movement language can teach their pupils in this way.

An original model which was developed through the present study generates **a change in the perception prevalent today** in the teaching of a theoretical topic: learning in the environment of a classroom, sitting on a chair next to a desk, and reading and writing in the textbook. The changed perception of the present study is grounded in studies of EWMN and the integration of movement and theoretical learning.

The originality of the study is manifested by the idea of integrating two subjects learnt at school, aiming to enrich the knowledge and improve the attitude of the learners. Today there is a complete separation between theoretical subjects and applied subjects associated with art and enrichment. The present study is not grounded in previous studies since no similar specific studies exist.

The present study contributes to practical knowledge **in Israel** due to the importance of thinking about and implementing curricula which integrate PA through EWMN. Three colleges of education already instruct and train students to teach EWMN in addition to organizing in-service training courses for teachers who have no training in PA. Hence, it is possible to train teachers to combine the knowledge of EWMN and theoretical topics.

The universal significance of the research findings resides in the fact that EWMN is an international and universal movement notation which is studied and known around the world. Consequently, this knowledge can be integrated with theoretical topics which can be taught as described in the present study.

Further research

It is recommended conducting further studies:

- ❖ Integrating PA through EWMN with additional theoretical topics.
- ❖ Integrating PA through EWMN and a theoretical topic in the upper school grades.
- ❖ Investigating teachers' viewpoint about the possibility to combine learning a theoretical topic and PA through EWMN.

SUMMATION

The factual conclusions indicated that the intervention program by PA through EWMN enables an integration of theoretical topics learnt at school with topics learnt according to EWMN. Moreover, they illustrated that the intervention program resulted in higher scores and more positive attitude towards the learnt theoretical subject.

The conceptual conclusions presented an interdisciplinary learning model which is based on and integrates three areas of knowledge: PA, EWMN, and two theoretical topics (angles and symmetries). The model integrates three aspects through three points of view: the teacher, the pupil and cognitive perception. This can be achieved by the integration of PA through EWMN which facilitates learning of theoretical topics. The practical implications entail a new perspective on teaching a theoretical topic, the development of the model as a an independent learning unit, and the option of demonstrating it during in-service training courses for teachers with or without knowledge of physical education. The present study expanded and enhanced the existing knowledge.

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