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FUTURE PRESCHOOL TEACHERS' ATTITUDES TOWARDS THE INTEGRATION OF THE STEM LEARNING APPROACH IN EARLY CHILDHOOD PRACTICE

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Abstract: The research aims to assess the attitudes of future preschool teachers toward the integration of the STEM learning approach in early childhood practice before and after the introduction of the Conceptual PlayWorld model (CPW). The sample of the research is future preschool teachers (N=46) who attended the obligatory course Methodical Practicum of Getting to Know the Environment (MPGKE) and the optional subject Children's Play and Creativity (CPC) during which they developed the CPW, as a model of the integration of the STEM learning approach in early childhood practice. The attitudes of future preschool teachers were examined using a five-point Likert-type scale. The findings indicate that this model can create conditions for a positive shift in the attitudes of future preschool teachers towards the application of the STEM learning approach in preschool age, that it can be one of the models for the application of the STEM learning approach in early childhood practice, aligned with the understanding of learning and development of preschool children and that it needs to be further studied and developed in our educational context.

Keywords: STEM learning approach, Conceptual PlayWorld (CPW), future pre-school teachers, early childhood practice

INTRODUCTION

The concept of a STEM learning approach (science, technology, engineering, and math) has grown in popularity in recent years. When the STEM learning approach is used for addressing education curriculum, it typically refers to an integrative approach to teaching and learning (Zendler, Seitz, & Klaudt, 2018). The STEM learning approach is considered to enable meaningful learning. Teachers and preschool teachers believe that such learning will contribute to students'/children's better activity and their ability to participate critically in knowledge acquisition (Tippett & Milford, 2017). Young children are curious, creative, and collaborative; the same characteristics are needed for STEM education, and these characteristics in young children make them naturally

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interested in the STEM approach (Banko et al., 2013). The STEM learning approach encourages children to build knowledge about the world around them through observation, research, and questioning (Ata Aktürk, Demircan, Şenyurt & Çetin, 2017). Children are interested in STEM learning (DeJarnette, 2018). They are deeply engaged in the learning process (Tank, Rynearson, & Moore, 2018; Tippett & Milford, 2017). STEM serves children by improving their vocabulary, encouraging their collaboration, and transmitting their learning into their future experiences (Moomaw & Davis, 2010).

Research points to the increasing importance of applying the STEM learning approach in working with preschool children but, at the same time, it is emphasizes that educators' competence is insufficient to integrate the mentioned learning approach in early childhood practice because models for its application are mainly developed for school practice and applied in the school context (Stephenson, Fleer, Fragkiadaki, & Rai, 2021) which is not completely in accordance with the understanding of learning and development of preschool children. In addition, preschool teachers' views of STEM learning approach in the early childhood context can be illustrated as follows (Wan , Jiang, & Zhan (2020): considerable number of teachers (62%) perceive STEM as separate disciplines while only a small part of them (6.79%) illustrated STEM as an integrated approach to teaching (Simoncini & Lasen, 2018); part of teachers (30%) worried about the appropriateness of STEM education in the early childhood context (Park, Dimitrov, Patterson, & Park, 2017); various challenges were perceived by preschool teachers for STEM approach in the early childhood context, including practical constrains (such as time, instructional resources, administrative support, and support of colleague), preschool teachers' capacity (such as understanding and handling the curriculum developed by researchers, subject content knowledge, and lack of professional development) and concerns about children (such as interest, developmental differences, and safety) (Baigiati & Evangelou, 2015; Jamil,Linder, & Stegelin,   2018); John et al., 2018; Park, Dimitrov, Patterson, & Park, 2017); although preschool teachers had a positive attitude toward professional training program, they hesitated to implement STEM lessons with their young children (DeJarnette, 2018).

When preschool teachers feel inadequate in certain areas of work, they usually do not engage enough in working with children in that area, which leads, in this particular case, to insufficient practice of the STEM learning approach in working with children.

The positive impact of the CPW on the preschool teachers' professional development emerged as an important finding (Fleer, 2022). While most studies on preschool teachers' competencies focus on what they do not know in the domain of STEM learning approach integration (Gomes & Fleer, 2017; 2018), the CPW draws on preschool teachers' strengths in designing play-based programs where program goals are oriented toward learning as well as the overall development of children (Fleer, 2022). Integrated and exciting experiential learning enhances children's interest in the STEM concept and helps them develop skills that they need in the 21st century. A study (Stephenson, Fleer, Fragkiadaki & Rai, 2021) found that through participation in the CPW professional development, preschool teachers: positively experienced STEM teaching and gained new tools; gained self-awareness for transforming their STEM teaching practices; increased their motivation and competence; devoted more time to STEM experiences; and shifted their professional identity as teachers of STEM.

Based on these findings, the idea of our research is to enable future preschool teachers to practice the STEM learning approach through the CPW model during initial education in order to, at least partially, prevent the above-mentioned findings.

THEORETICAL BASIS OF THE CPW

The CPW was created by Professor Marilyn Fleer based on many years of research and search for the STEM learning approach in preschool education. One can ask why it is so important to have models of teaching STEM built on research undertaken in play-based settings in the early childhood contexts. First, in conceptualizing this problem, we have to understand the unique nature of the early childhood contexts (Fleer, Fragkiadaki, & Rai, 2021), where "learning takes place in social, mainly play-based situations and is formed on the basis of children's daily experiences and interests" (Barenthien, Lindner, Ziegler, & Steffensky, 2020: 338). Second, we need to also understand the unique developmental period of the preschool child (Fleer, Fragkiadaki, & Rai, 2021). Young children's leading activity is play (Vygotsky, 1966), and it is through play that teaching programs for learning are usually organized by teachers (Siry & Kremer, 2011). Third, teacher motivation in intentionally teaching science also matters (Fleer, Fragkiadaki, & Rai, 2021). In the literature on early childhood teachers' professional development, it has been noted that teachers' motivation for practice change (Nuttall et al., 2015) is oriented towards designing and implementing effective play-based programs (Hadley, Waniganayake, & Shepherd, 2015).

There are many playing models in the literature, playing conceptions in different cultures, and definitions of what play is and what it is not. Many play theories focus on the playing stages, where children progress from manipulative finger play, and later material and solitary playing, through parallel to role play or fantasy playing. A cultural-historical playing view does not focus on age-related stages of play development. Play arises as a result of the dialectic between children's psychological functioning and the social and material conditions available in the environment (Fleer, Fragkiadaki & Rai, 2020). Vygotsky (1966) identifies two key elements for playing understanding that distinguish this perspective from the developmental perspective. First, playing emphasizes the creation of imaginary situations that are related to the games' roles and rules. Second, changing meanings of actions and objects are needed in a play (Vygotsky, 1966). Children manage objects and create meanings while they play, where objects and actions are given a new meaning (Vygotsky, 1966) through imaginary situations as the "basic unit of play" (Elkonin, 2005:13). Vygotsky said that "play contains all the developmental tendencies in a condensed form; in play it is as though the child were trying to jump above the level of his [sic] normal behaviour" (Vygotsky, 1966: 16).

The first step in creating the CPW was the cultural-historical synthesis of two binary values – play and learning into a conceptual play (Fleer, 2011). A cultural-historical understanding of imagination theorizes the bridge between play and learning in programs that seek to support concept formation. A dialectical view of imagination and cognition is placed in the foreground, and through this, the theory of play, called conceptual play, is introduced. It is argued that conceptual play will help preschool teachers to develop concepts with children in play-based programs. The second step was to study and incorporate the play world. The foundations of the play world began with the research of Gunilla Lindqvist (Lindqvist, 1995) in Sweden. The world of play is an approach that involves preschool teachers in children's play and foregrounds the problem scenario as part of the construction of the earliest play. The central assumption that underpins the world of play is that a preschool teacher has an active role in changing the conditions of children's play. A preschool teacher creates a dramatic situation with the children through the collective acting out of the plot found in stories, fairy tales or children's books. Children live the characters' experiences and relive their emotions together through the narrative while dramatizing the story. "The interplay between emotion and intellect gives rise to the development of imagination while they play" (Lindqvist, 1995:49). Further research into the STEM learning and playing has led to the Conceptual PlayWorld (Fleer, Fragkiadaki & Rai, 2020) as a model for the application of the STEM approach (Fleer, 2018; 2019) which has been studied in various segments of the STEM, Scientific PlayWorld (Fleer, 2017a), Digital PlayWorld (Fleer, 2017b) and Engineering PlayWorld (Fleer, 2020).

THE CPW IN A TEACHING PROCESS

The CPW was introduced through the teaching of two subjects, the compulsory subject Methodical Practicum of Getting to Know the Environment and the optional subject Children's Play and Creativity. Students were introduced to the theoretical assumptions of the model and were gradually guided, based on the literature (Fleer et al., 2023; Fleer, Fragkiadaki, & Rai, 2020; Fleer, 2018), through the CPW designing. They were tasked with designing the CPW based on a story of their choice and a plan given in the literature. Five characteristics of a CPW to support imaginary play and STEM thinking and learning (Fleer, 2018): 1. Selecting a story for the CPW; 2. Designing a CPW space; 3. Entering and exiting the CPW space; 4. Planning the play inquiry or problem scenario, and 5. Planning adult interactions to build conceptual learning in the role.

RESEARCH METHODOLOGY

The aim of the research was to assess the students'/ future preschool teachers' attitudes towards the integration of the STEM learning approach in early childhood practice before and after the CPW model introduction.

The research sample comprised students/future pre-school teachers (N=46) who attended the compulsory course Methodical Practicum of Getting to Know the Environment and the optional subject Children's Play and Creativity.

The descriptive method and scaling technique were applied. The research instrument was a five-point Likert-type scale containing 12 items (DeJarnette, 2018) that was adapted for research purposes. The scale measured three dimensions of attitudes (the importance of applying the STEM learning approach in preschool age, the STEM learning approach knowledge and ways of its reception in early childhood practice, and confidence in applying the STEM learning approach in practice). A higher average value indicated greater acceptance of a particular dimension.

The students'/future preschool teachers' attitude towards the integration of the STEM learning approach in early childhood practice was measured before and after the CPW model introduction. The reliability of the scale was defined by the Krombach alpha coefficient (0.859 before, 0.915 after). Arithmetic mean with a corresponding standard deviation was used for the description. The differences in the attitude between the two time intervals were examined with paired samples of a T-test (Paired T-Test).

RESEARCH RESULTS WITH DISCUSSION

The questionnaire items were grouped into three dimensions: the importance of applying the STEM learning approach in preschool age, the STEM learning approach knowledge and how to adopt it in early childhood practice, and preschool teachers' self-confidence regarding the application of the STEM learning approach into practice. *Table 1* presents the differences in students' attitudes on the dimensions before and after the introduction of the STEM learning approach.

Table 1. Differences in students' attitudes on the dimensions before and after the introduction of the STEM learning approach

Scale dimensions	**Before**		**After**		**t**	**df**	**p**
	M	**SD**	**M**	**SD**			
Application importance	4.04	0.63	4.40	0.43	-3.069	45	0.004
Knowledge	3.28	0.61	4.19	0.50	-7.861	45	0.000
Self-confidence	3.93	0.63	4,35	0.45	-3.622	45	0,001

M = arithmetic mean, SD = standard deviation, t = paired samples, T-test, df = degrees of freedom, p = statistical significance. Theoretical range: 1 = strongly disagree, 5 = strongly agree.

The respondents were more aware of the importance of the STEM learning approach being applied in preschool after the model introduction compared to the measurement before (M = 4.40, SD = 0.43 vs. M = 4.04, SD = 0.63), t = -3.069, df = 45, p = 0.004. The STEM learning approach knowledge and its application in early childhood practice was also better after the model introduction (M = 4.19, SD = 0.50 vs. M = 3.28, SD = 0.61), t = -7.861, df = 45, $p < 0.001$. A statistically significant difference also existed when it came to the dimension: self-confidence regarding the STEM learning approach application in early childhood practice (t =-3.622, df = 45, p = 0.001). Self-confidence was higher in the second measurement (M = 4.35, SD = 0.45) compared to the first (M = 3.93, SD = 0.63).

In the following text, we will refer to individual items within each dimension. The future preschool teachers' attitudes regarding the importance of the STEM learning approach application (*Table 2*) in preschool age were both high and equal before and after the model introduction. Within this dimension, a statistically significant difference was established on all three items. Therefore, preschool teachers believed in the importance of the STEM learning approach being applied in preschool age, both before and after the model introduction, and we could say that the model influenced the strengthening of that belief.

Table 2. The importance of the STEM learning approach being applied in pre-school age.

The item No.	**The importance of STEM learning approach being applied in pre-school age**	Before		After		**t**	**df**	**p**
		M	**SD**	**M**	**SD**			
p1	I will regularly use the STEM learning approach in working with children.	4.17	0.71	4.46	0.50	-2.227	45	0.031
p11	I believe that the STEM learning approach application in a real program is important for the holistic development of preschool children.	3.98	0.88	4.28	0.54	-2.004	45	0.051
p12	I believe that science, technology, engineering, and math concepts and activities are appropriate in working with preschoolers.	3.96	0.92	4.46	0.50	-2.901	45	0.006

M = arithmetic mean, SD = standard deviation, t = paired samples, t = test, df = degrees of freedom, p = statistical significance. Theoretical range: 1 = strongly disagree, 5 = strongly agree.

When it comes to the STEM learning approach knowledge and the way of its reception in early childhood practice (*Table 3*), it was evident that the future preschool teachers, observing individual items, before the model introduction, expressed a heterogeneous attitude, while after the model introduction, their attitudes were quite high and equal on all items. Before the model introduction, the future preschool teachers expressed a moderately high attitude towards their ability to plan and apply the STEM learning approach in the real kindergarten program and also towards the ability to design, monitor, and document strategies for children's learning and development process in connection with the STEM learning approach application. The preschool teachers perceive as moderate (average around 3.00 before the model introduction, average above 4.00 after the model introduction) their STEM learning approach knowledge, familiarity with strategies and resources for the STEM learning approach implementation in the real kindergarten program and their understanding of how the STEM learning approach could be integrated into the development of the real kindergarten program. We may conclude that the model had an impact on a positive change in the pre-school teachers' attitude towards the STEM learning approach knowledge and ways of its reception in practice, but also that there was room for further work in this domain.

A statistically significant difference was not observed on the item: "*When I start working, I will need professional training to include the STEM learning approach in the real kindergarten program more effectively and more often*."

The score on the item is equal and moderately high both before and after the model introduction. This showed us that future preschool teachers were aware of the need for continuous professional development in this domain.

Table 3. The STEM learning approach knowledge and ways of its reception in practice.

The item No.	STEM learning approach knowledge and how it is adopted in practice	Before		After		t	df	p
		M	SD	M	SD			
p5	I understand how the STEM learning approach can be integrated into the development of a real kindergarten program.	3.17	0.93	4.22	0.66	-6.349	45	0.000
p6	I am familiar with the strategies and resources for the STEM learning approach implementation in a real kindergarten program.	2.85	0.94	4.24	0.52	-8.244	45	0.000
p7	I can plan and apply the STEM learning approach in a real kindergarten program.	3.80	0.75	4.41	0.50	-4.556	45	0.000
p8	I am able to come up with strategies for monitoring and documenting children's learning and development processes related to the application of the STEM learning approach.	3.57	0.83	4.26	0.61	-4.317	45	0.000
p9	When I start working, I will need professional training to include the STEM learning approach in the real kindergarten program more effectively and more often.	3.96	0.82	4.15	0.84	-1.086	45	0.283
p10	I am well-versed in the STEM learning approach.	2.85	1.03	4.07	0.71	-6.725	45	0.000

M = arithmetic mean, SD = standard deviation, t = paired samples, t = test, df = degrees of freedom, p = statistical significance. Theoretical range: 1 = strongly disagree, 5 = strongly agree.

When we considered individual items within the Self-Confidence dimension regarding the STEM learning approach application in practice (*Table 4*), the preschool teachers showed a high degree of self-confidence after applying the model on all items and after introducing the model. There was no change in the preschool teachers' attitudes regarding the enjoyment of the STEM topics development with children. It was high both before and after the model introduction, which showed us that future preschool teachers would be happy to develop STEM topics with children, in general. After the model introduction, the future preschool teachers were more positive about their comfort in the STEM learning approach planning and implementation with children. They were particularly more positive regarding the statement that the STEM learning approach inclusion in their future work was within reach. These findings indicated that after the model introduction, there was an increase in future preschool teachers' self-confidence regarding the STEM learning approach application in practice, particularly in the domain of preschool teachers' familiarity with this approach.

Table 4. Self-confidence regarding the STEM learning approach application in practice.

The item No.	Confidence in STEM learning approach application in practice	Before		After		t	df	p
		M	SD	M	SD			
p2	I feel that I will feel comfortable in the STEM learning approach planning and application with children.	4.11	0.60	4.37	0.49	-2.136	45	0.038
p3	I think I will enjoy the STEM topics development with children.	4.24	0.79	4.46	0.50	-1.529	45	0.133
p4	I believe that the STEM learning approach incorporation into my future work is within reach.	3.57	1.11	4.17	0.68	-3.199	45	0.003

M = arithmetic mean, SD = standard deviation, t = paired samples, t = test, df = degrees of freedom, p = statistical significance. Theoretical range: 1 = strongly disagree, 5 = strongly agree.

Our research findings were in agreement with the research results (Stephenson, Fleer, Fragkiadaki, & Rai, 2021). They indicated that thanks to the CPW model, future preschool teachers had gained a positive experience and a new tool for the STEM learning approach integration; they improved their competence and self-confidence in the STEM learning approach application and were encouraged to build their professional identity as STEM preschool teachers.

CONCLUSION

The findings indicated that the CPW model could create conditions for preschool teachers' positive attitude shift toward the STEM learning approach application. The future preschool teachers' change of attitude occurred in all three domains: the STEM learning approach knowledge and the way of its reception into practice; the importance of the STEM learning approach application in preschool age and self-confidence regarding the STEM learning approach application in practice. The CPW model can be one of the models of the STEM learning approach application in early childhood practice aligned with the preschool children's learning understanding and their development, but it should be further studied and developed in accordance with our practice/context.

Special attention should be paid to the initial future pre-school teachers' education and they should be trained to practice this or other adequate models for the STEM learning approach application in educational work during their studies. Among other things, future preschool teachers should be encouraged to apply this approach to gain working experience with children through their participation.

The limitations of our research referred to the number of respondents, which was determined by the number of students who attended the subjects. A suggestion for future research refers to the model application with students in practice and the techniques and instruments' designing which will enable us to look at different aspects of their application.

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