

Mixt-technology for the development of environmental competence in physical education classes in 7-9-years-old children

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Abstract:

Environmental education of children is a part of the educational process. The purpose of the scientific research is to test the pedagogical mixed technology for the development of environmental competence in 7-9-years-old children with the help of means and methods of physical education. *Materials and methods.* The research project involved 44 secondary school students in Chelyabinsk (Russia). The children of the experimental group were engaged in a curriculum based on interdisciplinary connections between physical culture and ecology. At each lesson, the children performed physical exercises with imitation of ecological behavior at home and outdoors. The program of the third lesson per week included all-weather outdoor activities. The children performed home creative tasks (research projects) of an ecological and health-improving orientation. In the control group, environmental education was carried out according to the traditional form. A high-stakes monitoring of the ecological footprint and motor qualities was carried out. *Results.* Cognitive, emotional-cognitive and behavioral criteria of environmental competence significantly increased in EG children, as well as their interest in physical activity and motor qualities, compared with children where training was conducted using a traditional educational program. *Conclusions.* The combination of children's ecological and physical education under the conditions of school education is the basis for eco-culture and health care of the younger generation formation.

Key Words: physical activity, physical education (PE), pedagogical technology, environmental competence

Introduction

The intense human impact on the natural human environment has led to a large-scale ecological crisis aggravation of (Lin et al., 2018) and the formation of the so-called «ecological footprint» (Collins et al., 2020). Under these conditions, the role of the ecological worldview and behavior skills in the natural environment development among the world's population increases (Laurent et al., 2021), especially among the younger generation.

In recent years, the orientation of the educational process in educational institutions has become based on nonlinear pedagogy. Such education provides for significant student autonomy and the use of a research approach in an academic subject development. It allows children to acquire relevant twenty-first century competencies more effectively (Lee et al., 2017). The discipline «Physical Culture», which is aimed not only at the physical perfection of the child, but also at the development of various competencies that are necessary for him in everyday life, is no exception. The importance of physical culture in educational institutions follows from the position that it allows successfully reducing physical inactivity, which is widespread among young people. Studies by De Meester et al. (2018), Huang et al. (2019) indicate that in more than 50% of primary school-age children, physical activity does not correspond to the recommended amount of daily physical activity. Significant prevalence of inactivity among the modern generation of children and youth is one of the causes of obesity (Denisova, 2019), diabetes, high blood pressure and mortality (Ding et al., 2020).

One of the nonlinear pedagogy directions is the development of environmental knowledge and skills among students (Sara Moreno Pires et al., 2022). A key role in the environmental competence formation among young people is assigned to a comprehensive school, which lays not only the foundations of a worldview, but also ways to implement environmental safety requirements (Higgins et al., 2022). The parents' environmental

outlook plays a role in the environmental knowledge education (Jancis, & Gavenauskas, 2022). It is believed that education aimed at environmental education makes strategic changes in the child's daily environment and non-linearly affects the increase in physical activity and improves the child's health (Mark O'Sullivan et al., 2020; Ming Hui Li et al., 2022).

The competence-based approach use has significantly modernized the field of youth education. This approach increases the importance of multifunctional literacy development in children and the possibility of realizing knowledge and skills, including in solving environmental issues. According to experts, the age of 7-9 years is the most favorable for the individual's ecological culture development (Sergeeva, Stanina, 2018). At this age, children begin to actively develop non-standard thinking, intellectual abilities, moral qualities and a positive attitude towards nature protection, a significant trace of physical activity in the open air is formed.

Different types of competence development in children effectively occurs using interdisciplinary connections between academic disciplines (Gordeeva, 2017). An interdisciplinary approach in the environmental education of children using the subject «Physical Culture» is shown in the research (Mishchenko, 2019). According to the author, «interdisciplinary connections» are one of the essential principles of environmental education and the further formation of the individual's ecological culture. Physical education organization is closely connected with the surrounding nature. These conditions include the use of natural factors as a means and environment for physical activity, hardening and hygienic procedures (Arja Sääkslahti, Donna Niemistö, 2021; Salvatore Pignato et al., 2021). Familiarity with the surrounding nature begins with preschool institutions when organizing children's physical activity, as shown by the example of Finland (Hermundur Sigmundsson, 2021). A significant number of training hours performing physical exercises are conducted outdoors in direct contact with the natural environment (Boris Jidovtseff et al., 2021). It is known that outdoor activities increase children's interest and motivation for physical activity, which in the long term leads to a decrease in diseases (Wu et al., 2017). The role of outdoor exercise during the COVID-19 pandemic was particularly positive (Leclerc et al., 2020). Environmental competence is an insufficiently studied issue, especially in primary school children. The scientifically developed system of practical realization of opportunities for environmental knowledge, skills and abilities formation in younger schoolchildren by means of physical culture is insufficiently developed. We believe that the results of our research will allow teachers of educational institutions to use educational technologies of physical education to develop children's environmental competence and improve their physical condition.

The purpose of the scientific research is to test the pedagogical mixed technology for the development of environmental competence in 7-9-years-old children using the means and methods of physical education

Material & methods

The research project was carried out in the 2021-2022 academic year on the basis of a secondary school in Chelyabinsk (Russia). 44 second grade students of two groups took part in the project – the control group (CG, n=22) and the experimental group (EG, n=22). The educational process of the children of CG and EG was organized in accordance with the physical education program in the amount of 3 academic hours per week (Lyakh, 2012). In the classroom, CG students studied according to the traditional methodology of environmental competence formation, EG group used the technology of nonlinear pedagogy proposed by us, and the third lesson was organized outdoors in a forest park line. The research included three stages, Table 1.

Table 1. Research program

Aim	Tasks	Project stages	Work content
High-stakes testing of the level of environmental competence and physical fitness formation in children-students	- to determine diagnostic criteria for the environmental competence level in children and to select methods for its assessment; - to analyze the initial level of environmental competence and physical fitness formation in children.	I	The study of scientific and methodological literature. Analysis of pedagogical experience. Testing the level of environmental knowledge, skills and attitudes (cognitive, emotional-value and behavioral criteria). Scientific analysis of the test results.
Development and testing of technology for the environmental competence formation in children in PE classes.	- to develop technological maps of PE classes with a research approach element; - to test the proposed pedagogical technologies.	II	Approbation of the proposed pedagogical technology effectiveness for the students' environmental competence formation under the conditions of constant use of research approach elements in physical education
High-stakes testing of the environmental competence formation and physical fitness level and the proposed technology effectiveness evaluation	- to assess the environmental competence formation level in children at the end of the research project; - to offer recommendations for the environmental competence effective formation in children.	III	Analysis of the conducted research project effectiveness on the environmental competence formation among schoolchildren and interpretation of the research results.

Monitoring of the environmental competence formation level assessment among schoolchildren was carried out at the beginning and at the end of the project using an open method of pedagogical testing with the determination of the three criteria characteristics for the development of this competence: cognitive, emotional–value and behavioral, Table 2.

Table 2. Criteria and blocks of environmental competence formation in schoolchildren

Criteria	Blocks
Cognitive	1. Depth and consistency of environmental knowledge; 2. Interest in the environmental problems study.
Emotional–value	3. The concept of the nature value for man; 4. The manifestation of an emotional–value attitude to the natural environment.
Behavioral	5. Practical use of environmental knowledge, skills and abilities; 6. Motivation for environmental protection activities.

The assessment of the environmental competence state in points, the level of assessment and the expressiveness of the indicator are presented in Table 3.

Table 3. The level and expressiveness of the environmental competence indicator

Score in points	Score level	Indicator expressiveness	The sum of points for one criterion
5	High	Expressed	9 - 10
4	Average	Expressed, but there are errors	7 - 8
3	Below average	Expressed weakly	1 - 6
2	Low	Test failed	0

The maximum score for each of the three criteria = 10 points. According to the sum of the three criteria scores, the following levels of environmental competence formation were determined: 25-30 points - high level; 20-25 points – average; 15-20 points – low.

In the physical education of children in the experimental group, the pedagogical technology developed by us was used, which provided for interdisciplinary connections between physical and environmental education. The classes were differentiated into individual and group ones, on the organization of the objects presentation (excursions), on the tasks organization (quizzes, environmental games and hikes), on the children's activities organization (research and project activities, collective physical work outdoors). As part of the experiment, we have developed technological maps of PE lessons, which include topics related to environmental education. At each lesson, for 10 minutes, the children performed physical exercises with imitation of ecological behavior at home and outdoors. The program of the third lesson per week included all-weather outdoor activities. We conducted quizzes with motor activity, relay races, outdoor and sports games. EG children performed home creative tasks (research projects) of an ecological and health-improving orientation.

High-stakes testing of physical fitness was carried out using control physical exercises: running at 30 m, s; mixed movement at 1000 m, m/s; pulling up at a low bar from a lying position, the number of times; bend forward from a standing position, cm. The data obtained were processed by statistical methods using licensed programs STATISTICA 10.0 and MS Excel 2010. The reliability of the indicators differences was calculated according to the Student's t-test. The reliability of the share distribution of indicators was determined by the value of the chi-square criterion (χ^2). Differences in the indicators values were considered statistically significant at $p < 0.05$.

Parental consent for the participation of children in the research project was obtained. The project carried out does not violate the legal foundations of children and their parents provided for by the Helsinki Declaration of 2008.

Results

The high-stakes testing results analysis of the environmental competence state in schoolchildren is presented in Table 4.

Table 4. The indicators values of the environmental competence level of children of CG and EG at the beginning and at the end of the research project, in points, $M \pm m$

No	Criteria for the environmental competence level		CG (n=22)		EG (n=22)	
			At the beginning of the project	At the end of the project	At the beginning of the project	At the end of the project
1	10-point rating scale	Cognitive	5.4 ± 1.32	6.8 ± 2.52	5.2 ± 1.28	8.8 ± 2.21*
2		Emotional–value	5.1 ± 1.16	6.9 ± 2.62	4.9 ± 1.11	8.9 ± 2.54*
3		Behavioral	5.6 ± 1.45	6.7 ± 2.51	5.5 ± 1.41	9.2 ± 3.11*
4	The total indicator of environmental competence (30-point scale of assessment)		16.1 ± 2.41	20.4 ± 3.13	15.6 ± 2.33	26.3 ± 3.93*

Note. * - the difference is significant, $p < 0.05$

At the beginning of the research project, approximately the same level of indicators values for all criteria of environmental competence was established in children in CG and EG, $p > 0.05$, Table 4. After the research project completion, an increase in the indicators values of all criteria in both groups was established. A significant increase was registered only in children of the experimental group, $p < 0.05$. The increase in the values of the indicators of the environmental competence criteria of children in both groups at the end of the research project is illustrated in the Figure.

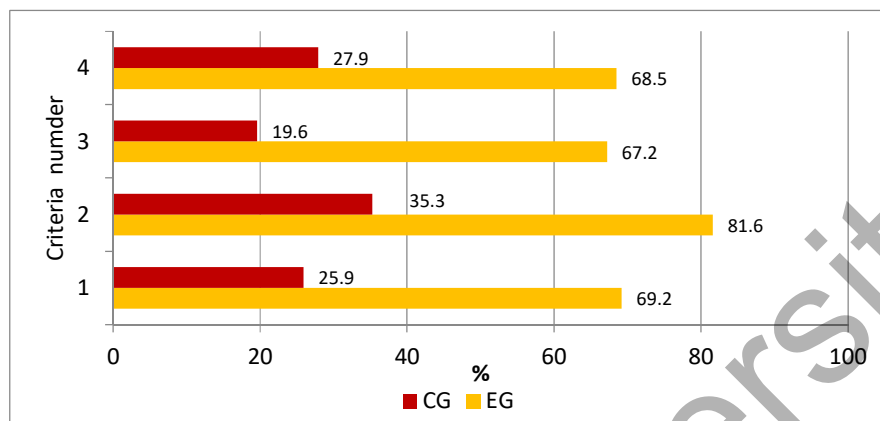


Fig. The increase in the indicators values of environmental competence criteria in children of both groups at the end of the research project

At the end of the project, the increase in the indicators values of all criteria of environmental competence of schoolchildren of the experimental group turned out to be significantly greater than that of children of the control one.

For example, in No. 1 by 2.7 times, No. 2 by 2.3 times, No. 3 by 3.4 times, the total indicator is 2.4 times more. The number of children with different criteria for the environmental competence formation at the beginning and at the end of the research project is presented in Table 5.

Table 5. The number of CG and EG children with different criteria for the environmental competence formation at the beginning and at the end of the research project, %

Criterium	Level	CG		EG	
		At the beginning of the project	At the end of the project	At the beginning of the project	At the end of the project
Cognitive	«low»	57.7	36.4	62.1	4.5*
	«average»	31.0	50.0*	31.1	36.4
	«high»	11.3	13.6	6.8	59.1*
Emotional-value	«low»	54.5	40.9	59.1	9.1*
	«average»	36.4	50.0*	36.4	59.1*
	«high»	9.1	9.1	4.5	31.8*
Behavioral	«low»	63.6	59.1	59.1	4.5*
	«average»	27.2	31.7	36.4	31.8
	«high»	9.2	9.2	4.5	63.7*

Note. * - the difference is significant, $p < 0.05$

At the beginning of the research project, the number of children with different criteria for the ecological competence formation was approximately the same, Table 5. In both observation groups, in all criteria there were $> 50\%$ of children with low and high levels, single children were registered.

At the end of the project, the CG showed a significant increase in the number of children with only an average level in two criteria. In the EG, there was a significant decrease in the number of children with low levels and an increase in the number of children with medium and high levels of environmental knowledge, skills and abilities, Table 5.

This pedagogical mixed technology of motivated physical education of schoolchildren aged 7-9 allowed to significantly increase the children of the experimental group physical fitness level, compared with the results of testing the motor qualities of CG children, Tables 6 and 7.

Table 6. High-stakes testing results of motor qualities (boys CG and EG), $M \pm m$

TestNo	Test	CG		EG	
		At the beginning of the project	At the end of the project	At the beginning of the project	At the end of the project
1	Running at 30 m, s	7.24±0.62	6.92±0.57	7.28±0.66	5.15±0.88*
2	Mixed movement at 1000 m, m/s	8.43±0.92	7.34±0.76	8.55±0.95	6.25±0.52*
3	Pulling up at a low bar from a lying position, the number of times	5.0±0.24	7.5±0.45*	5.0±0.32	14.5±2.98*
4	Bend forward from a standing position, cm	1.4±0.22	3.2±0.43*	1.2±0.20	5.6±0.67*

Table 6. High-stakes testing results of motor qualities (girls CG and EG), $M \pm m$

TestNo	Test	CG		EG	
		At the beginning of the project	At the end of the project	At the beginning of the project	At the end of the project
1	Running at 30 m, s	7.54±0.64	7.12±0.59	7.48±0.65	5.45±0.72*
2	Mixed movement at 1000 m, m/s	9.43±1.02	8.44±0.89	9.50±1.05	7.45±0.43*
3	Pulling up at a low bar from a lying position, the number of times	3.0±0.16	5.0±0.34*	3.0±0.42	10.0±1.32*
4	Bend forward from a standing position, cm	3.2±0.14	5.5±0.64*	3.2±0.23	8.5±0.97*

At the end of the research project, the improvement of motor qualities in boys and girls of both experimental groups was established. The greatest increase in the values of testing indicators is noted in the EG children, where the pedagogical technology proposed by us to improve environmental competence was used. The research results analysis shows that the proposed experimental technology for improving environmental knowledge, skills and abilities in 7-9-years-old children in the process of physical education proved to be more effective than the traditional one.

Dicussion

From an early age, a child is faced with situations where the harmonious coexistence of a person with the natural environment is unthinkable without environmental knowledge, competencies and behavioral skills. At school age, children learn the nature of things and phenomena through subject-based learning. Primary school age is favorable for the physical qualities and environmental competencies development (Sergeeva, & Stanina, 2018). In our project, we tested a pedagogical mixed technology for the environmental competencies development in 7-9-years-old children in physical education classes, as we consider this topic relevant and timely. Children's and adolescents' health status deterioration in many countries of the world requires the search for new pedagogical directions and technologies of physical activity for the young people's health (De Meester et al., 2018; Ding et al., 2020).

In the last decade, nonlinear pedagogy based on ecological dynamics has become increasingly popular in the educational process with young people (Lee et al., 2017; Pires et al., 2022). It focuses on the child and provides him with greater autonomy, which, according to the authors, creates motivation for learning, unlike linear education, where the pedagogical process is focused on the teacher's instructions and requirements. We consider the use of technology for the environmental competence development as one of the elements of nonlinear pedagogy. At the beginning of the research project, we found that the CG and EG children's environmental competence was developed approximately equally, as evidenced by the results of the experiment. At the end of the research, we obtained significantly more effective results of educating younger schoolchildren ecological competence using the pedagogical technology we proposed, which is consistent with the results of scientific works where technologies of nonlinear pedagogy based on environmental dynamics were used. According to Lee et al. (2017), training in modified tennis technology using nonlinear learning based on environmental dynamics turned out to be more effective. This is due, according to the authors, to the fact that such training encourages teachers to create curricula with the inclusion of problematic and situational tasks, research, social and practical projects, which stimulates children's motivation and interest in classes.

Mark O'Sullivan et al. (2020) believe that education aimed at environmental education has a non-linear effect on increasing physical activity and improves the child's health. The data obtained by us on the children's of the experimental group motor qualities development confirm the conclusions of these authors and other researchers. For example, an ecological approach inclusion in the educational environment has allowed increasing the physical activity of children in Hong Kong (Ming Hui Li et al., 2022). Testing the children's motor qualities, where the mix technology proposed by us was used, showed a significant increase in results, which was not observed in children where the traditional technique was used. According to our results, this is

due to a significant increase in the environmental knowledge, skills and abilities level according to all criteria in children of the experimental group, compared with the traditional training program. The use of the natural environment in the organization of the third PE lesson plays a role in increasing interest in classes. The natural environment is an effective means of increasing the children's motor development and reduces the effect of physical inactivity on the body, increases the health level (Boris Zhidovtsev et al., 2021; Salvatore Pignato et al., 2021).

Thus, the issues of developing children's educational competencies (knowledge, skills and abilities) of an ecological orientation using the means and methods of physical culture are relevant for the pedagogical community and require further study.

Conclusions

The ecological competence formation in children in physical education lessons develops a respectful attitude to the surrounding nature, the rules of environmental behavior and physical activity. We have tested a pedagogical mixed technology for an ecological footprint formation using the means and methods of physical culture. After the research, the children of the experimental group showed a significant increase in the values of indicators of all environmental competence criteria. The increase in the indicators value of the cognitive component in EG was 2.7 times greater, emotional-value in 2.3, behavioral in 2.4 times, the total indicator of environmental competence increased by 2.4 times, compared with the results of the children of the control group, $p < 0.05$. In EG, there was a significant decrease in the number of children with a low level of environmental knowledge, skills and abilities, and the number of children with medium and high levels increased. A significant increase in the number of children with only an average level in two criteria of environmental competence, $p < 0.05$, was found in the joint venture.

The use of interdisciplinary connections in physical education classes at EG increased interest in physical activity, as indicated by the results of testing the motor qualities of children at the end of the project. In the children of the experimental group, the values of the indicators of all motor tests were significantly higher than in the children of the control group, $p < 0.05$.

The approbation of the pedagogical mix-technology of physical education proposed by us showed its effectiveness in improving the environmental competence of younger schoolchildren compared with the traditional method of conducting classes.

Conflicts of interest. The authors declare no conflict of interest.

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