**STEM Education on the Example of the "Physics for Kids" Program implemented in the Hippo Art Non-Public Kindergarten**

**in Wieliczka. Research reports.**

Education STEM (science, technology, engineering, maths) is increasingly bolder in educational institutions and especially in elementary schools and kindergartens (Giza 2016: 16). In recent years, the number of educational tools and aids has also increased significantly. Looking at the interest in training and conferences regarding STEM and programming, it can be safely said that from year to year the number of teachers expanding their workshop with scientific research methods and digital data carriers (see https://www.mentorpolska.pl/steam [access: August 5, 2019]). It is particularly interesting to enrich the methodology of pre-school education with classes characterized by research methods of seeking new experiences with children, and gaining scientific knowledge about the world around them (Adamek, Bałachowicz 2014: 49).

One of the ongoing initiatives in this field of education are the activities of the Creative Thinking Science Foundation. It was founded at the beginning of 2016 by its founder and founder Piotr Sołkiewicz. This foundation implements educational programs such as "Play with science", "Power of the mind", "Physics for Kids", "Fascinating world of insects" in educational establishments, schools and kindergartens (see http://planetaziemia.com/fizyka-dla - drying [access: 02/08/2019]).

The goal of the Foundation is, inter alia, to promote science and technology, popularize exact and technical sciences, including support and promotion of modern, innovative education methods. In addition, from the point of view of assumptions, it is important to create programs in the field of scientific, technical, creative and pro-ecological education for children and adolescents (see http://planetaziemia.com/fizyka-dla-smyka [access: 02.08.2019]).

In this article I would like to analyze the results of research on the implementation of the "Physics for Kids" Program in one of the private kindergartens. The program was implemented in the 2017/2018 school year. Research issues focus on adapting the content and methods of work to the individual needs and interests of children in kindergartens as well as on the aspect of innovation of the studied Program in the context of the current pre-school education program.

The curriculum innovation concerns the modification of the kindergarten curriculum (without violating the core curriculum) by implementing the proprietary program 'Physics for Kids'. Common to the emerging differences in approaches to innovation is that they all embrace the understanding of innovation in terms of innovation. In the literature on the subject, the concept of innovation is often identified with creativity (Schulz 1994: 84-104), it is claimed that creative thinking is in its nature innovative and inventive thinking, and the essence of creativity is always the innovative side of work. Innovation is thus a process of spreading innovation within a given institution, kindergarten (Popek 2001: 19). It should be noted, however, that the basic requirement for innovation is confirmation that they guarantee the implementation of the school's tasks, in particular the core curriculum, in this case kindergarten (Śliwierski 2010: 448).

In the process of pre-school education interactions, the aim should be to include students at various levels of cognitive development in the integrated universal system of education and upbringing (Lewowicki 1977: 89). Pursuant to the regulation on the pre-school education core curriculum, "teachers undertake actions aimed at individualized support for the development of each child, according to his needs and abilities.

The individualization of the educational process involves taking into account the differences in the development of individual children and adapting to them the content, methods, didactic measures and organization of the teacher's pedagogical activities. These differences also apply to general abilities (associated with intellectual operations) and special abilities, which Howard Gardner (Gardner 2002: 15) calls multiple intelligences. This author says that every person, and therefore also a child in preschool and early school age has multiple intelligences, but each one has a different connection and intensity. Therefore, the teacher must recognize the multiple intelligence of his pupils and develop them in the right direction. The author distinguishes the following types of intelligence: linguistic, logical-mathematical intelligence, visual-spatial, musical, interpersonal, intrapersonal, movement and nature intelligence.

The type of mathematical and logical intelligence is associated with shaping / developing children's interests in mathematics and other exact sciences, e.g. physics. Children are passionate about hypotheses and research, they love to do experiments and construct models. This type of intelligence is part of the educational workshops of the "Physics for Kids" Program.

According to the assumptions of Howard Gardner, the teacher should ask stimulating questions, arouse children's research interests, engage in children's activities, discover the rules governing the world together with the child, advise the child, encourage and motivate the child to research activities, respect children's individual experiences, disagreement; requirements tailored to the individual capabilities of the child; presenting the attitude of a teacher adapted to the individual situation (Gardner 2002: 19).

These principles are in line with the rules of individualization of educational interactions in the Helena Wolny kindergarten. According to the author, individualization consists in taking into account by the teacher, in the course of school education, the differences between students of the same age. These differences concern - according to the author - abilities, interests, pace of work, ways of acquiring knowledge and learning motivation (Wolny 1979: 29).

**Research issues:**

According to the assumptions of the authors of the Program, the classes "Physics for Kids" are scientific workshops that are designed through innovative methods of education, physical experience, to shape knowledge among children about the world around them. In addition, program content is to be adapted to different age groups of recipients. During the workshop, the organizers are to ensure that all children actively participate in the experiments carried out as assistants. The scenario of the shows is to enable children to participate in educational and scientific activities through play (see http://planetaziemia.com/fizyka-dla-smyka [access: 02.08.2019]).

The following research questions / problems arise:

1) What is the innovation of the educational program "Physics for Kids" in the context of the current assumptions of the curriculum for pre-school education?

- studied variable: innovation of the "Physics for Kids" educational program

2) What are the manifestations of individualization of educational interactions in the "Physics for Kids" Program towards preschool children?

- studied variable: manifestations of individualization of educational interactions in the "Physics for Kids" Program.

The purpose of this research is to determine whether the educational program "Physics for Kids" implemented in kindergartens has the hallmarks of program innovation. In addition, the purpose of the research is to verify whether the principle of methodological individualization in the teaching process is respected during the above classes.

The research group consists of parents and their children, recipients of the "Physics for Kids" Program. This group consisted of all Program participants in the kindergarten under study. The selection of class participants results from the principle of voluntary submissions of parents of children willing to participate in the Program. The children constituted two age groups: a group of younger children were 20 and over and a group of older children aged 5 and 6, also 20. On the other hand, 40 people were included in the study. The program was implemented in February-June 2017. The place of implementation of the Program was the Hippo Art Non-Public Kindergarten in Wieliczka.

Respondents, parents of children participating in the classes of the "Physics for Kids" Program, were asked to answer the questions contained in the survey. These were single-choice questions. The children, however, were subjected to examination by observation. This observation was categorized under problem areas.

Within the scope of this research problem, the following research hypotheses can be drawn: Probably the educational program "Physics for Kids" has the hallmarks of program innovation in the context of the current assumptions of the curriculum of pre-school education; It is likely that the educational impacts implemented during the "Physics for Kids" Program respect the principle of methodological individualization in the process of teaching preschool children.

**Presentation of research of different forms of individualisation of the educational impacts and the innovation of methods implemented during the "Physics for Kids"- Program addressed to preschool children. Analysis of test results.**

Research on the individualization of educational impact and innovation of the "Physics for Kids" Program addressed to preschool children covered the following thematic circles of the workshops: "secrets of magnetism", secrets of light, secrets of sound, secrets of air, secrets of electrostatics, "magic or science".

The individualization of the educational process in kindergarten and school is extremely important because it is related to taking into account the differences in the development of individual children in this process and the adaptation of the content, methods and organization of the teacher's educational activities to the differences of individual children (Lewowicki 1997: 30). For a teacher to be able to successfully apply the principle of individualization of the teaching process, he must respect the child's psychophysical properties, intellectual, emotional, social and limitations in this regard. He should use this knowledge to adapt the organization of the teaching process to the individual capabilities and needs of the child (Reid, Forrestal, Cook 1996: 107).

The respondents were asked to respond to the following aspects of the manifestations of individualization of upbringing of educational interactions: the involvement of teachers in searching / awakening the child's research interests, sending messages adapted to the cognitive predisposition of children; stimulating children to independently search for new ways to learn / study phenomena and physical properties in nature; the use of counseling, hints in the child's individual problem situations; respecting the child's individual experience / knowledge, disagreement; requirements adapted to the individual capabilities of the child; individual motivation of the pupil before and after the tasks performed; presenting the attitude of a teacher adapted to the individual situation and the individual needs of the child (non-directive attitude); individual motivation of the charge by presenting the personal advantages and qualities of the teacher-researcher as an example to follow.

Based on the analyzes resulting from my research and my own observations of classes, I notice that educational / educational impacts are not always adapted to the needs and cognitive abilities of children. Based on the conducted research, it can be said that the involvement of educators in individualizing some educational interactions is low.

Analyzing research results in terms of individualization of educational impacts in the process of shaping children's scientific thinking, several conclusions are drawn.

1) Among the interactions, methods of self-motivation, child motivation, requirements and non-directive attitude are more popular.

2) Teachers rarely use counseling, interviewing, broadcasting messages adapted to the intellectual predisposition of children, they do not seem to arouse the research interests of children

3) Not all children always keep up with the teacher. The knowledge provided sometimes requires additional or different processing. In the opinion of the surveyed group of respondents, educational suggestions and counseling do not achieve the intended result aimed at the proper orientation of cognitive behavior of all children.

4) Probably the selection of participants of the classes / children is incorrect or the groups are too numerous. Children do not always show interest in the classes.

The most commonly used method during the studied classes - own example, requires personal involvement and inspiration of pupils with yourself. The teacher inspires with his example on the way to acquire knowledge and new skills that are different than previously known and implemented in life. However, the less frequently used method - stimulating research, requires special arrangement of teachers and, at the same time, engaging children in relevant roles, functions and tasks.

All these methods can be conducive to acquiring new experiences and discovering the creative potential and possibilities of scientific exploration of the world and, in the future, also its surroundings. This approach in the implementation of pre-school education methods requires educators with a great talent and pedagogical sense. When working with a group of a dozen or so children of various types of cognitive capabilities, educators / teachers must be able to take reflexes in undertaking didactic activities creating scientific thinking of pupils.

In the remaining scope of research, the respondents were able to respond to the Program's innovation. They took into account the following manifestations of the Program's innovativeness: methods of transferring content in the form of experiences, experiments; activation of children to participate / assist in physical experiments; implementation of scientific thinking and cause-effect studies into application; shaping thinking and interpreting phenomena by learning about the relationships of various variables and the impact of different phenomena on each other; shaping beliefs about human impact on learning phenomena in nature by research methods. The children participated in six thematic modules. At each of these classes knowledge of physical phenomena in nature was passed on. In addition to discussions on a given topic, experiments were conducted to enable children to understand the meaning, properties, and sources of individual physical phenomena. The didactic means used were innovative and unusual, e.g. vacuum pump, laser, metal detector, electrostatic adhesive, conductors, insulators, sonometer and strobe. It can definitely be said that the classes of the "Physics for Kids"

Program are part of the canon of innovation in pre-school education. This is indicated by the forms of transmission of teaching content in the form of physical experiments. Physical experiments that teachers performed with the help of children include, among others: hanging an object in the air under the influence of a magnetic field, creating a rainbow phenomenon, splitting a beam of light, stopping a moving image, causing a storm , study of the phenomenon of acoustic resonance, pumping air using a vacuum pump, construction of the device for listening in, use of a sonometer to measure sound intensity, measurement of air weight, production of ionic breeze, electrostatic glue, electric battery, checking the fire resistance of the balloon, starting the antigravity generator.

Considering the content provided to the Program's addressees, they converge / fall within the assumptions of the core curriculum for preschool education. Thus, the Program in its innovation is also a guarantee of the implementation of the primary program tasks of the kindergarten. Pedagogical creativity underlying the innovations of the Program appears constantly in every class as part of educational activities.

The innovativeness of the "Physics for Kids" Program concerns changes in the teaching / learning process in the use of new methods, didactic means and forms of work with a child, teacher's workshop, presentation of material, consolidation or checking of knowledge and skills, children. Less refers to the scope of the curriculum that coincides with the core curriculum. However, teaching techniques are innovative, for known content, teaching and teaching styles. This kind of innovation preschool teachers can qualify for changes modernizing their classes.

Pedagogical innovations are certainly a big challenge for preschoolers. Pedagogical creativity underlying the "Physics for Kids" Program is a response to the needs of the constantly changing circumstances of modern preschool education. Innovation is an indispensable condition for the development of modern kindergarten. A creative teacher makes an effort by proposing solutions that will answer the specific needs of the child. The innovative program "Physics for Kids" is a support for the comprehensive development of the child, taking into account the changes taking place in broadly understood education, contributes to the attractiveness of the kindergarten.

**Summary**

One of the ways to search for non-schematic / innovative ways to work with a child in kindergarten is to use problem methods in the education process and to take appropriate didactic measures aimed at stimulating and developing the activity of the mind and imagination of children (Kozuh 2016: 43). This is where the experimental research and demonstration methods undertaken by teachers of the "Physics for Kids" program, which are designed to shape children's scientific thinking, perfectly fit in.

The task of a creative / creative and innovative preschool teacher is to encourage and open the minds of children to create unusual solutions and to submit unconventional ideas of exploring the world. This involves the need to individualize educational impacts. The barrier to the development of children's creativity is neglecting, bypassing the peculiar individuality of pupils at their pace of work, the specifics of thinking, existing cognitive experiences, differences in the development of deductive / inductive thinking, or a specific difficulty among children in handling new concepts in the course of learning by teachers. Almost all the authors dealing with the problem of creative / innovative education agree that, for this reason, working with a student improving their creative competences is a responsible and very difficult activity (Kozuh 2016: 42). Adaptation and individualization of content and forms of work with children by the persons conducting the examined Program "Physics for Kids" was not always fully implemented.

This fact may be an opportunity to reflect on possible modifications and transformations of the system of pre-school teacher education. Perhaps it is worth introducing academic classes that would set students - future teachers - tasks that require innovative methodological solutions and at the same time enable an individual approach to the development of scientific thinking of children in kindergartens.

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Akty prawne:

1. Rozporządzenie Ministra Edukacji Narodowej z dnia 27 sierpnia 2012 r. w sprawie podstawy programowej wychowania przedszkolnego oraz kształcenia ogólnego w poszczególnych typach szkół (Dz. U. z 2012r., poz.977 ze zm.).