SCIENTIFIC ARTICLES
ARTYKUŁY NAUKOWE

EETP Vol. 14, 2019, No. 4(54)
ISSN 1896-2327 / e-ISSN 2353-7787
DOI: 10.35765/eetp.2019.1454.07

Submitted: 16.08.2019
Accepted: 19.11.2019

Suggested citation: Kranc M. (2019). *STEM Education on the Example of the "Physics for Kids" Program Implemented in the Hippo Art Non-Public Kindergarten in Wieliczka: Research Reports*, "Edukacja Elementarna w Teorii i Praktyce," vol. 14, no. 4(54), pp. 95-107.
DOI: 10.35765/eetp.2019.1454.07

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STEM Education on the Example of the "Physics for Kids" Project Implemented in the Hippo Art Non-Public Kindergarten in Wieliczka: Research Reports

Edukacja STEM na przykładzie warsztatów programu "Fizyka dla Smyka" realizowanych w Niepublicznym Przedszkolu Artystyczno-Językowym Hippo Art w Wieliczce. Raport z badań

KEYWORDS

"Physics for Kids" project, developing creative activity, individualization of educational impacts, child's mental creativity, child's behaviour creativity

ABSTRACT

The author of the article presented the results of the research aimed at recognising and describing the ways in which preschool children's creative activity is stimulated. The children described in the article are the participants of the "Physics for Kids" project fulfilled by the Scientific Foundation "Creative Thinking." In particular, the research was to verify the way of shaping creative thinking and acting, as well as the signs of individualization of educational impacts.

The research was carried out with the use of the diagnostic survey method and the technique of a categorised observation and a questionnaire. The research results show that, during the fulfilment of the project in question, children's creative intellectual operations and actions based on making experiments are shaped. However, the adjustment and individualization of the contents and forms of working with children by the ones who carried out the "Physics for Kids" project has not always been fully implemented.

SŁOWA KLUCZOWE

program „Fizyka dla Smyka”, stymulowanie twórczej aktywności, indywidualizacja oddziaływań edukacyjnych, twórcze działania dzieci, twórcze myślenie dzieci

ABSTRAKT

W niniejszym artykule zaprezentowano wyniki badań mających na celu rozpoznanie i opisanie przejawów stymulowania twórczej aktywności dzieci w wieku przedszkolnym. Są one adresatami programu „Fizyka dla Smyka”, realizowanego przez Fundację Naukową „Twórcze Myślenie”. W szczególności chodzi tu o zweryfikowanie kształtowania twórczego myślenia i działania oraz przejawów indywidualizacji oddziaływań edukacyjnych.

Badania zostały przeprowadzone metodą sondażu diagnostycznego techniką obserwacji skategoryzowanej oraz ankiety. W wyniku przeprowadzonych badań można stwierdzić, że podczas realizacji badanego programu kształtowane są wśród dzieci twórcze operacje umysłowe oraz działania oparte na wykonywaniu doświadczeń. Jednakże dostosowywanie, indywidualizowanie treści i form pracy z dziećmi przez prowadzących badany Program „Fizyka dla Smyka” nie zawsze było w pełni realizowane.

Introduction

STEM education (Science, Technology, Engineering, Mathematics) is getting more and more popular in educational institutions – especially at primary schools and preschools (Giza 2016: 16). Also, within the last years, the number of educational tools and materials has significantly increased. As people are getting more and more interested in training sessions and conferences concerning STEM and coding, we can say that, year after year, there are more and more teachers who apply scientific research methods and digital data carriers (cf. https://www.mentorpolska.pl/steam). It is particularly interesting to extend the methodology of kindergarten education by the classes during which the children gain new experience with the use of scientific methods, and increase their knowledge of the world in a scientific manner (Adamek, Bałachowicz 2014: 49).

One of the initiatives fulfilled in this scope of education includes the actions of the Scientific Foundation “Creative Thinking.” It was established at the beginning of 2016 by Piotr Sołkiewicz. The foundation carries out various educational projects in schools, kindergartens and other institutions. The examples of such projects include: “Learn and Play,” “The Power of Mind,” “Physics for Kids,” “The Fascinating World of Insects” (cf. http://planetaziemia.com/fizyka-dla-smyka).

One of the objectives of the Foundation is to promote the development of science and technology, as well as exact sciences, including the promotion of creative, modern and innovative methods of education. Moreover, from the point of view of the

Foundation's assumptions, it is important to create the projects concerning scientific-technical, creative and environment-friendly education for children and youth (cf. ibidem).

In this article I would like to analyse the results of the research concerning the "Physics for Kids" project carried out in a private kindergarten. The project was fulfilled in the school year 2017/2018. The research issues are focused on verifying the stimulation of creative activity of the researched children during the fulfilment of the "Physics for Kids" project.

Stimulation of the preschool children's creative activity – theoretical basis

Creativity – which is the highest form of practice – is, at the same time, the best and, sometimes, the only way to satisfy the man's new needs, as well as the optimum factor that facilitates the man's development (Kurowska, Łapot-Dzierwa 2018: 132). In the context of children, creativity is perceived as a complex activity as a result of which new ideas, compositions (the development of creative thinking) and original products (the development of creative acting) are created (Hurlock 1985: 74-75).

From their earliest years, children are active and like to learn about the people and the world, creating their own image of everything. In order to support them, it is good to develop their cognitive curiosity, imagination, divergent/convergent thinking, problem-solving, as well as creative action in speaking and acting. Creative action is any cognitive and emotionally-motivational action that leads to subjectively or objectively new and valuable products in different areas of life (Dąbek 1988: 9).

The child's creative activity is visible in playing the basic condition for which is openness to new experiences, following the stimuli provided to the individual in the process of learning, and the exposition to a wide range of experiences (Zborowski 1986: 25-26).

With reference to preschool children, one should organise educational and upbringing actions that support and develop their playfulness and expression, as well as activity and creative skills. In the process of educating, it is important to take into account different types of learning through fun, as well as different forms of activity and didactic materials.

In order to support the children's creative activity, one should:

- make it possible for them to solve problems through participating in creative fun activities;
- introduce the habits of particular kinds of behaviour in the situations typical of the collective "brainstorming";

- stimulate aiming at self-fulfilment with the use of self-awareness;
- improve and stimulate the children's creative imagination and visual expression;
- encourage the children to use the materials that develop their creativity;
- provide the proper atmosphere and conditions that facilitate creative activity;
- make it possible for the children to learn about the world through searching for, discovering and solving open tasks;
- stimulate the children's playful activity which develops their creativity, thinking skills, imagination, and gives them the joy of acting (Płóciennik 2010: 38).

The strategies of organising an active process of studying include stimulating developmental changes and organising educational situations with the use of the task and problem method. Such activities include tasks to be done by the child, tasks done by the child together with the teacher, activating didactic materials, and interactions between the child and the teacher that introduce the child into the world of new experiences (Płóciennik 2010: 44-45). Stimulation of creative activity is only possible if thinking and creative action is developed according to the child's individual needs and abilities (Jąder 2008: 7).

The teacher's success in working on the development of the child's creative activity depends on the individualization of educational impacts, reliable pedagogical knowledge, good knowledge of each child and their needs, and the adjustment of didactics to the child's intellectual level, skills, interests, and temperament (Zborowski 1986: 46-47).

According to the regulation concerning the preschool core curriculum of 2017, "the teachers support the child's independent exploration of the world (...), respecting their individual needs and interests."[1] Individualization of the educational process means taking into account the differences in the development of particular children and adjusting contents, methods, didactic means and the organization of the teacher's pedagogical actions to those differences (Lewowicki 1977: 89).

According to the assumptions of Howard Gardner, the teacher has to ask stimulating questions, arouse the children's scientific interests, get involved in the children's actions, discover the laws governing the world together with the child, give advice to the child, encourage and motivate the child to research activities, respect the children's individual experiences and their different opinions, adjust the requirements to the child's individual possibilities, present the attitude of the person adjusted to the individual situation (Gardner 2002: 19).

[1] Regulation of the Minister of National Education of 14th February 2017 concerning the core curriculum for preschools and primary schools, including those which teach slightly or significantly intellectually disabled students, as well as the 1st grade vocational school, special school preparing for a profession, and post-secondary schools (Journal of Laws 2017, item 356), appendix no. 1.

These principles comply with the rules of individualization of educational impacts in the kindergarten of Helena Wolny. According to the author, individualization means that the teacher, in the course of school education, takes into account the differences among the students who are at the same age. In the author's opinion, those differences are related to the abilities, interests, pace of work, ways of acquiring knowledge and motivation to learn (Wolny 1979: 29).

Methodological assumptions of the authors' own research

According to the assumptions of the authors, the "Physics for Kids" project includes scientific workshops aiming at shaping the children's knowledge of the world through innovative educational methods and physical experiments. The contents are to be adjusted to different age groups of the participants. During the classes, the organizers shall make sure that all the children actively participate in the experiments as their assistants. The scenario of the presentations is to make it possible for the children to participate in educational-scientific classes while having fun (cf. http://planetaziemia.com/fizyka-dla-smyka).

The objective of the research was recognizing and describing the ways of stimulating the creative activity of the children participating in the "Physics for Kids" project.

The main problem was the question: What are the ways of stimulating the creative activity of the children participating in the "Physics for the Kids" project? On the basis of this question, the following detailed problems were formulated:

1. What are the signs of shaping creative thinking and acting of the children participating in the "Physics for Kids" project?
   - the analysed variable: the signs of shaping creative thinking and acting of the children participating in the research;
   - indicators for the analysed variable:
   - shaping creative intellectual operations among the children: deductive and inductive reasoning, metaphorizing, creating associations, abstracting (Kurowska, Łapot-Dzierwa 2018: 134);
   - tasks and actions based on making experiments, using materials that arouse creativity, building things, solving open-ended tasks and problem tasks (Płóciennik 2010: 38).
2. What are the signs of individualization of the stimulation of creative activity of the children participating in the "Physics for Kids" project?

- the analysed variable: the signs of individualization of the stimulation of creative activity of the children participating in the "Physics for Kids" project.
- Indicators for the analysed variable:
- developing the children's research interests, presenting messages adjusted to the children's cognitive predispositions, encouraging the children to search for the new ways of studying/analysing phenomena and physical properties in nature, giving advice in the children's individual problem situations, respecting the individual views and different opinions of the children, adjusting educational requirements to the children's individual possibilities, individual evaluation and motivation of the children, the adjustment of the teacher's attitude (non-directive one) to the children's individual requests and needs, motivating the children through presenting the advantages of being a researcher of the reality.

The necessary condition for adequate and reliable research is the proper selection of the people to be analysed, i.e. selecting a number of respondents from a group of people in whom the researcher is particularly interested. We usually speak about the random or purposeful selection of the sample. The random selection means that the researched people are selected from a given population in a completely accidental manner. In the purposeful selection, the researcher chooses people from a given population on his own (Łobocki 2019: 178-179). In this research, the research area and sample was chosen purposefully.

The purposeful selection of the sample turns out to be useful in pedagogical analyses when random selection is impossible (which was the case in this situation). The fulfilment of the project in question took place in a specifically selected kindergarten. The purposeful selection of the sample turns out to be particularly useful if the subject of the research is an experiment or quasi-experiment in implementing new methods of teaching. To make this research more credible, it is certainly good to purposefully choose the respondents – the children subject to the experimental/new methods of teaching related to the "Physics for Kids" project. The research sample was selected purposefully to obtain the results that actually refer to the analysed educational impacts that were chosen in advance (Łobocki 2019: 181).

The research group includes the children and parents participating in the "Physics for Kids" project. The group included all the participants of the project in the analysed kindergarten. The parents, who wanted their children to take part in the project, submitted proper documents to the project organisers. The children formed two age groups: the younger group – children aged 3-4 (20 people), and the older group – children aged 5-6 (20 people). 17 boys and 23 girls participated in the research, which means that 40 children were involved in the project. The children fall within the scope of the intellectual norm and they have been going to the kindergarten since at least six

months. All the research participants (children) have successfully adapted to learning in the kindergarten. Also, the parents of the children were subject to the research (40 parents). The project was fulfilled from February to June 2017 in the Hippo Art Non-public Kindergarten in Wieliczka.

The subject of this research is the behaviour of the students and the teachers during the classes related to the "Physics for Kids" project fulfilled in the Hippo Art Non-public Kindergarten in Wieliczka. The children's behaviour refers to the tasks performed during the classes, their involvement and activity. Moreover, we are interested in the students' utterances spoken during the classes. Those utterances confirm the development of the children's creative thinking.

The children were included in the analysis with the technique of categorised observation. The schedule of observation includes the following two categories of watching the children's behaviour:

- the signs of the students' activity during the classes (stimulating the children's creative activity);
- the students' utterances during the classes (stimulating the children's creative thinking).

The last area of the research interest is the activity of the teachers during the classes, i.e. supporting the children while taking into account their individual differences and needs. The parents took part in a survey. They were to answer the questions concerning the behaviour and utterances of the teachers during the classes in terms of individualization of educational activities: motivating the students, giving advice, giving communicates, talking to the children, arousing the children's interests, and stimulating the children using their own example.

Analysis of the research results

The analysis of the signs of stimulating the creative activity of the children included in the "Physics for Kids" project included the following thematic circles of the classes: the mysteries of magnetism, the mysteries of light, the mysteries of sound, the mysteries of air, the mysteries of electrostatics, "magic or science?"

Individualization of the educational process in the kindergarten and at school is very important, as it is related to taking into account the differences in the development of particular children, and the adjustment of the contents, methods and the teacher's pedagogical actions to the individual differences among the children (Lewowicki 1977: 30). If the teacher wants to successfully implement the principle of the individualization of the didactic process, he/she has to respect the child's psychological and physical features, his/her intellectual, emotional and social abilities, as well as

limitations. The teacher should use such knowledge to adjust the organization of the teaching process to the child's individual needs and abilities (Reid, Forrestal, Cook 1996: 107).

The respondents were to comment on the following aspects of the individualization of educational impacts: the teachers' involvement in searching for/arousing the child's scientific interests; giving communicates adjusted to the children's cognitive predispositions; encouraging the children to look for the new ways of learning about/analysing phenomena and physical properties in nature; giving advice in the child's individual problem situations; respecting the child's individual experiences/knowledge and the children's different opinions; adjusting the requirements to the child's individual possibilities; individual motivation of the child before and after the fulfilled tasks; presenting the attitude of the teacher adjusted to the individual situation and individual needs of the child (a non-directive attitude); individual motivation of the student through presenting the teacher-researcher's personal assets and values as the example to be followed.

Based on the analyses resulting from my research and observation of the classes, I have noticed that the educational/upbringing impacts are not always adjusted to the children's needs and cognitive abilities. Based on the research, one can determine that the teachers' involvement in the individualization of certain educational impacts is very low.

Table 1. The signs of the individualization of stimulating the creative activity in the "Physics for Kids" project among the preschool children, in the opinion of the parents

Aspects of educational impacts	**The signs of the individualization of educational impacts**	**The teachers' involvement N = 40**	
		The number of replies	**Percentage**
Arousing the children's interests	Active searching for/arousing the child's research interests	4	10%
Giving communicates	Giving communicates adjusted to the children's cognitive predispositions	3	7%
Stimulating the research quests	Encouraging the children to search for the new ways of learning about/exploring phenomena and physical properties in nature	13	32%

Aspects of educational impacts	The signs of the individualization of educational impacts	The teachers' involvement N = 40	
		The number of replies	Percentage
Giving advice related to upbringing issues	Giving advice in the students' individual problem situations	10	25%
Talking to the children	Respecting the students' individual views and opinions	13	32%
Establishing requirements	Requirements adjusted to the child's individual abilities	25	62%
Motivating the child	Individual evaluation and motivation of the student before and after fulfilling the tasks	28	70%
Recognising the child's needs	The teacher's attitude adjusted to the student's individual needs and requests (non-directive attitude)	25	62%
The teacher's own example	Presenting the values and assets of the teacher-researcher	34	84%

Source: Author's own research.

While analysing the research results concerning the individualization of educational impacts in the process of shaping the children's scientific thinking, we can draw several conclusions:

1. The most popular methods include giving one's own example, motivating the child, establishing requirements adjusted to the child's individual abilities and a non-directive attitude.
2. The teachers hardly ever give advice, talk to the children, provide communicates adjusted to the children's intellectual predispositions, and care for arousing the children's research interests.
3. Not all the children always follow the teacher's pace of work. Sometimes the knowledge has to be processed in an additional or different manner. According to the respondents, the educational suggestions and advice do not result in the assumed proper direction of all the children's cognitive behaviours.
4. The selection of the participants of the classes/children is probably improper or there are too many children in the groups. The children are not always interested in the classes.

The most popular method used during the classes is giving the children one's own example, which requires personal involvement and inspiring the students with oneself. The teacher inspires the children to gain new knowledge and skills. The method of stimulating the children's research quests is less popular and it requires a special preparation of the teachers, as well as making the children involved in certain roles, functions and tasks.

All those methods can facilitate gaining new experience and discovering one's creative potential and the possibility to learn about the world (and one's environment) in a scientific manner. Such approach in the fulfilment of the methods of kindergarten education requires talent and pedagogical skills from the teachers. While working with more than a dozen children of various personality traits and cognitive abilities, the teachers/educators have to skilfully take up didactic actions which shape scientific thinking of their students.

Other aspects analysed during the research included the signs of shaping creative thinking and acting among the researched children. The following signs were taken into account: shaping creative intellectual operations among the children: deductive/inductive reasoning, metaphorizing, associating things, abstracting (Bojakowska 2005: 9-10); tasks and activities based on experiments, using materials facilitating creativity, building things, solving open-ended tasks and problem tasks (Płóciennik 2010: 38).

The children participated in six thematic modules. Each of them focused on different physical phenomena in nature. Apart from the discussion on a given topic, the organisers made experiments making it possible for the children to understand the meaning, properties and source of particular physical phenomena. The tasks were based on making experiments. The materials/didactic aids facilitated the children's creativity. They included a vacuum pump, a laser, a metal detector, electrostatic glue, conductors, insulators, a sound meter and a stroboscope.

We can definitely say that within the "Physics for Kids" project the children's creative intellectual operations are shaped, as well as actions based on experiments are promoted. It confirms that the children's creative intellectual operations are shaped. The contents of the lessons were taught during physical experiments. The teachers stimulated the cause and effect thinking, deductive/inductive reasoning, associating things, and abstracting. They also shaped convergent thinking, i.e. concurrent intellectual operations. Convergent thinking, developed during the classes in question, included looking for one specific solution – one answer, in problem or task situations. The children were looking for the influence of one substance on another, they analysed the dependence and mutual impacts of particular physical phenomena.

The physical experiments made by the teachers with the children included: hanging a thing in the air with the use of a magnetic field; creating rainbow; dispersion of a wave of light; stopping the image that is moving; making a storm; analysing the phenomenon of acoustic resonance; pumping out the air with the use of a vacuum pump; making a device for overhearing; using a sound meter to measure the intensity of sound; measuring the weight of the air; making an ionic breeze; experimenting with electrostatic glue; making a battery; checking the fire resistance of a balloon; activation of an anti-gravity generator.

The pedagogical creativity being the basis of the innovativeness of the project appears in each of the classes conducted within the educational actions in question. Stimulating the creative activity in the "Physics for Kids" project refers to the changes in the process of teaching/studying in terms of new, creative methods, didactic means and forms of working with the child, as well as the teacher's methods, ways of presenting the knowledge, and reinforcing or checking the children's knowledge and skills. Didactic techniques are also new and creative. Due to the stimulation of the children's creative activity in the project, kindergarten teachers may treat this kind of impacts as a change that makes their classes more modern.

Stimulating the creative activity is certainly a challenge for preschool teachers. Pedagogical creativity, on which the "Physics for Kids" project is based, is the answer to the constantly changing requirements of the contemporary preschool education. Such creativity is a necessary condition for the development of the contemporary preschool. A creative teacher makes effort, offering the solutions that satisfy the child's particular needs. The innovative "Physics for Kids" project supports the child's general development, taking into account the changes taking place in broadly understood education, and it increases the attractiveness of preschool.

Summary

One of the areas of searching for the methods of stimulating the preschool children's creative activity are problem methods in the process of teaching/learning and proper didactic activities that aim at arousing and dynamizing the children's mind and imagination (Kozuh 2016: 43). A good example of such methods are experimental-research and presentation methods applied by the organizers of the "Physics for Kids" project, which aim at shaping the children's scientific thinking.

A creative and innovative preschool teacher should inspire and open the children's minds to creating unusual solutions and reporting non-typical ideas to learn about the world. It is connected with the necessity to individualize educational impacts. The children's creativity shall not be developed if the teacher neglects and ignores

their individuality in the pace of work, specific ways of thinking, previous cognitive experiences, differences in the development of deductive/inductive thinking, as well as the problem with using new terms by the teacher presenting the new material. Almost all the authors who refer to the problem of creative/innovative education admit that – because of the above – supporting the child in developing his/her creative competences is a responsible and very difficult task (Kozuh 2016: 42). Adjustment and individualization of the contents and forms of working with the child by the people who conducted the classes within the "Physics for Kids" project has not always been fulfilled.

This fact can be the opportunity to think about possible modifications and changes in the system of educating preschool teachers. Perhaps it is worth to introduce academic classes that would make future teachers face tasks that require innovative methodological solutions, and, at the same time, enable individual approach to the development of scientific thinking among preschool children.

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Legal acts

Rozporządzenie Ministra Edukacji Narodowej z dnia 14 lutego 2017 r. w sprawie podstawy programowej wychowania przedszkolnego oraz podstawy programowej kształcenia ogólnego dla szkoły podstawowej, w tym dla uczniów z niepełnosprawnością intelektualną w stopniu umiarkowanym lub znacznym, kształcenia ogólnego dla branżowej szkoły I stopnia, kształcenia ogólnego dla szkoły specjalnej przysposabiającej do pracy oraz kształcenia ogólnego dla szkoły policealnej (Dz.U. 2017, poz. 356).

Netography

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