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SCIENCE WORKSHOPS AND THEIR ROLE IN AWAKENING SCIENCE INTERESTS OF CHILDREN AND SCHOOL STUDENTS

WARSZTATY PRZYRODNICZE I ICH ROLA W ROZBUDZANIU ZAINTERESOWAŃ PRZYRODNICZYCH DZIECI I UCZNIÓW

Abstract: Development of science interests is one of many elements of the daily teachers' work at school. Finding out interesting forms of working with school students and their proper application at school allows for increasing science interests and to achieve many didactic aims. One of many of such proposals is an informal teaching which can be carried out while students participate in the various workshops, out of school meetings or science fairs.

Keywords: science, teaching methods, experiments, key-competences, science workshops

Introduction

Questions about the matter and influence of motivation, which is the permanent element of our life, have been the subject of human enquiry for centuries. The answer has been searched at many levels, in fields such as psychology, neurology, metaphysics etc. However, what motivates us to act and deal with obstacles that prevent us from achieving our aims, stays still largely unexplained. Not until today can scientists explain the individual differences in motivation to achieve particular goal. These reflections can, and should be, transferred to the field of our interest, which is education. Scientists distinguish two types of motivations - internal and external. While the first type of motivation depends on the student himself (the student takes certain type of action if he/she feels a certain need; it is a result of his/her interests or passions), the second one is influenced immensely by a team of teachers (external motivation appears when the action is implemented by external stimuli) [1]. According to Joanna Chromik-Kavacs the role of motivation in school is enormous - one of the most important tasks of a teacher, a tutor, and an educator is to increase impact to undertake an action or to direct a student's efforts to a certain goal [2]. There are many possibilities, according to the author the basic tasks are recognition, relying on and referring to the student's needs and interests and then, on the basis of that, giving

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him/her a sense of having influence on the learning process, providing opportunities to be successful in a certain field or using a variety of didactic measures, as well as forms and methods of work. Combining theoretical activities with practice gained in everyday life seems to be an interesting solution.

The teacher plays a very important role in creating interests, and what follows, he/she has an influence on the whole process of education. Introducing the practical activities aimed at focusing a student's attention on the practical value of knowledge allows to develop the very basic skills as well as profits for the whole society in the future [3, 4]. It is obvious that key competences play important role in teaching natural science. According to the European Union the basic competences for lifelong learning are supported by knowledge, skills and attitudes [5]. Characterizations of some key competences are presented in Table 1.

Table 1

Characterizations of some key competences [3, 4]

The skill of efficient and meaningful communication in all types of situations	A student should know how to express thoughts precisely; obtain the feedback information, which should be understood accurately	Interpersonal communication plays an important role in living and functioning in the society
The skill of efficient cooperation in a group	A student should know how to cooperate in a group, be responsible for fulfilling a task, pursue a common goal	Modern man cooperates with others more and more (at home, in family, at work); independently of the task he/she has to perform, he/she is obliged to cooperate with different people; modern man must be prepared to play a certain function/role in society and, in the same time, to change his/ her roles: of a leader, a partner, a subordinate
The skill of resolving problems in a creative way	A student should be able to notice unusual matters, problems and search for non-typical, creative solutions	Modern labour market requires creative people who are able to solve problems and act effectively in unusual situations

Science fairs and science workshops as a kind of informal learning

We present a modified workshop scenario for a child, which was used during the annual Science Fairs in Krakow. This kind of informal learning will motivate children to find connections between their own world and scientific concepts. Fairs and workshops provide motivation toward exploring and understanding these links through funny, safe, hands-on activities using inexpensive everyday life materials found at home [6]. Applying the human senses - seeing, hearing, touching, tasting and smelling plays an important role in that kind of activity. Nowadays learning by participation in the science fairs are a very popular, informal way of learning [7, 8]. So, we can find *eg* a variety of information about forthcoming The World Science Festival/ Fairs in 2014 as a kind of celebration of science [9].

Putting it into practice showed that the topic created large interests both among students with their teachers and crowds of parents with children, who were actively participating in presented experiments. However, it has to be underlined that this scenario

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can also be used during the chemistry lessons, as well as in many types of optional courses, during which the teacher can play various roles. This idea is presented in Figure 1.

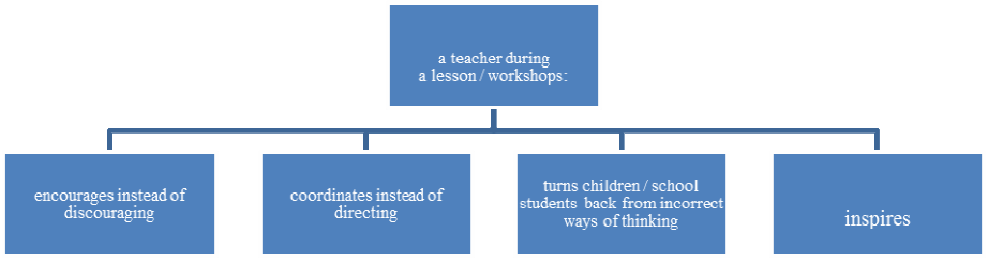

Fig. 1. The teachers roles in learning-teaching process

You really learn by doing - a chosen proposal of workshops for The Science Fairs and their modifications for using in school

These particular classes were preceded by a survey conducted in April 2011 among students from the randomly selected secondary schools in Krakow (N = 105). The main aim of this research was to test students' awareness of chemical substances, which can be found in the first-aid kit in every house. The information about the group of responders and the results of the research are shown in Figures 2-4.

The results showed, school students' knowledge about chemical substances in the first aid kit is very good. The most often mention substance by them was hydrogen peroxide. Awareness of chemical substances presence in everyday life, particularly in first aid kit was observed among children taking part in workshop at science fair. Interestingly, hydrogen peroxide appeared as the first word associated with first aid kit during interview with children participated in this workshop.

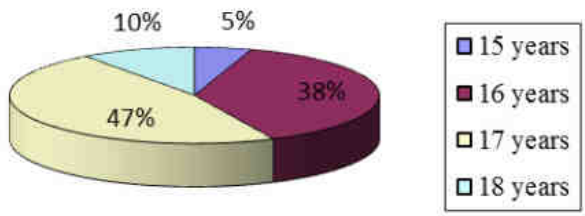

Fig. 2. The number of school girls and their age

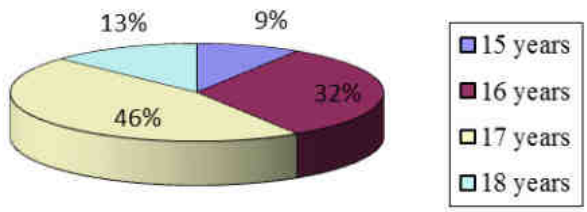

Fig. 3. The number of school boys and their age

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In order to introduce to the topic we can use some didactic games, so popular among children, like a riddle or a simple rebus (Fig. 5).

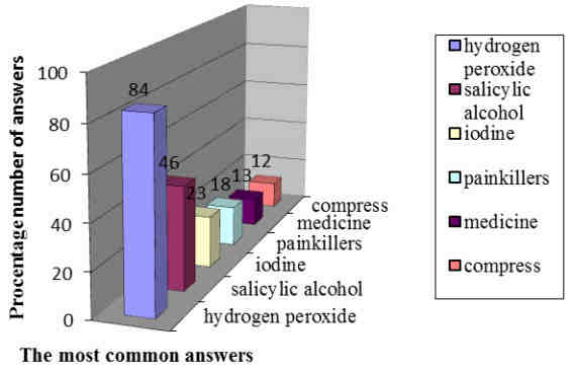

Fig. 4. The number of the most popular answers

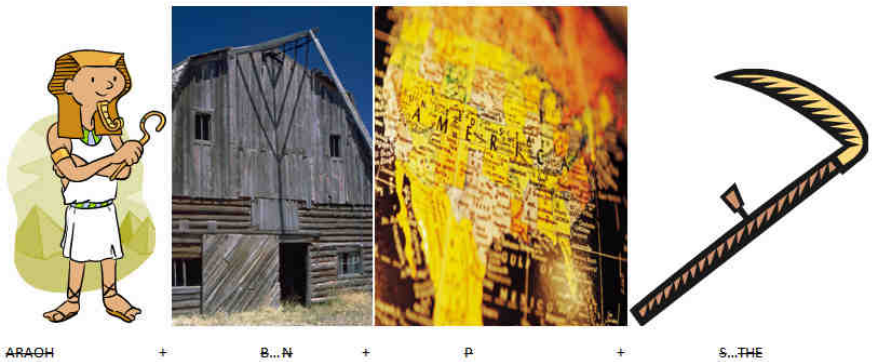

Fig. 5. Rebus

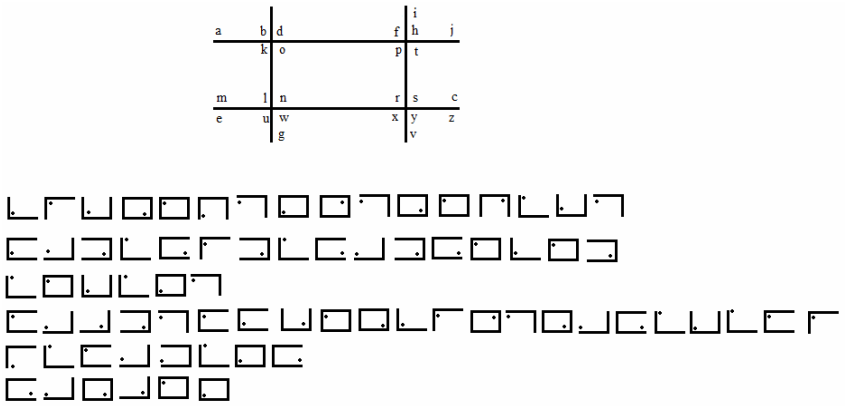

Fig. 6. Riddle

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The "first-aid rebus kit" workshop has been carried on with the usage of commonly available over the counter medications such as Rivanol, Vitamin C.

However, in order to present to the participants the main substrates that will be used in the experiments, we propose solving an unusual and very interesting riddle (Fig. 6).

IODINE

Introductory question:

What the iodine tincture is? Do you know what is it used for?

Iodine tincture is a homogeneous mixture containing the following substances: iodine, potassium iodide, ethanol, and water. Most frequently, it is a 3% solution. Iodine tincture is used for local disinfection of wounds and epidermal abrasions.

Exercise:

Analysis of a label from a bottle of iodine tincture

Experiment:

Laboratory glassware & equipment, reagents: Petri dishes, cutting board, rasper, knife, iodine tincture, potato, starch flour, wash bottle with water

Description of the experiment, observations and conclusions:

a) Put a drop of iodine tincture on a freshly cut potato (or rasped on a rasper).
b) Put a drop of iodine tincture on some flour or a piece of bread, then add several drops of water from wash bottle.

In each case, dark blue color confirms presence of starch.

HYDROGEN PEROXIDE

Introductory question:

What the hydrogen peroxide solution is? What is it used for?

Hydrogen peroxide solution is a homogeneous mixture containing hydrogen peroxide is a dissolved substance, and water is the solvent. Hydrogen peroxide solution is a 3% solution. 30% water solution of hydrogen peroxide is called perhydrol. Hydrogen peroxide solution is used for disinfection of wounds.

Exercise:

Analysis of a label from a bottle of hydrogen peroxide solution

Experiment:

Laboratory glassware & equipment, reagents: 3 beakers, test tube, rasper, strainer or gauze, knife, potato, yeast, liver, hydrogen peroxide solution, manganese(IV) oxide

Description of the experiment, observations and conclusions:

a) Put the following substances in 3 narrow beakers:
- potato filtrate (potato rasped on narrow mesh of the rasper, then rubbed through the strainer or gauze)
- yeast
- liver

Then, introduce hydrogen peroxide solution to the beakers.

b) Add a pinch of MnO_2 to the test tube with hydrogen peroxide solution (approx. 5 cm^3).

In all cases, we observe intensive evolution of a gas.

Comments:

Hydrogen peroxide is a compound with oxygen atoms in –I oxidation state. Foaming is caused by rapid release of a gas product. The gas liberated is oxygen: $H_2O_2 \rightarrow ½O_2 + H_2O$.

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It is noteworthy that MnO_2 is not consumed during decomposition of hydrogen peroxide solution (it remains on the bottom of the test tube), and this proves it is a catalyst.

The same role is played by catalase present in blood - it is an enzyme catalyzing decomposition of hydrogen peroxide solution to water and oxygen. The same enzyme is contained in *eg* potatoes and liver. Also starch may be a catalyst of decomposition of hydrogen peroxide solution.

SALICYLIC ALCOHOL

Introductory question:

What salicylic acid solution is? What is it used for?

It is a weak disinfectant used for skin disinfection after epidermal abrasions, in acne and seborrhea.

Exercise:

Analysis of a label from a packaging of salicylic alcohol

Experiment:

Materials for the experiment should be prepared earlier.

Laboratory glassware & equipment, reagents: salicylic alcohol, water solution of iron(III) chloride, little brush, filter paper

Description of the experiment, observations and conclusions:

a) paint symbols of elements on the filter paper, using a thin brush dipped in salicylic alcohol
b) rub the dried filter paper with little brush dipped in water solution of iron(III) chloride.

Violet symbols of elements appear.

Comments:

Salicylic acid solution is a homogeneous mixture, containing salicylic acid as a dissolved substance, and ethanol (or sometimes a mixture of ethanol with water) as a solvent. Salicylic alcohol solution is a 2% solution.

Violet color proves the presence of –OH group directly connected to aromatic ring in salicylic acid molecule.

BITTER SALT

Introductory question:

What is bitter salt used for? *It is used in medicine, among others as a laxative.*

Exercise:

Analysis of a label on a package of bitter salt

Experiment:

Laboratory glassware & equipment, reagents: test tube, sulfuric(VI) acid, magnesium, wooden chip, matches

Description of the experiment, observations and conclusions:

Put several magnesium turnings into a test tube with sulfuric(VI) acid. Then put a burning match to the outlet of the tube. We observe generation of gas, the burning match causes a characteristic „puff".

Comments:

Bitter salt is magnesium sulfate(VI). One of synthesis methods of this salt is a reaction of the metal with the acid.

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RIVANOL

Introductory question:

What is rivanol used for? *Rivanol is used in the case of purulent infections of skin, mucous membranes, and wounds (also those healing up with difficulties), oral cavity infections, epidermal abrasions, burns.*

Exercise:

Analysis of a label on a bottle of Rivanol

Experiment:

Laboratory glassware & equipment, reagents: test tube, universal indicator papers, water solution of potassium nitrate(III), hydrochloric acid, Rivanol

Description of the experiment, observations and conclusions:

Add hydrochloric acid to a test tube with 1 cm^3 of water solution of potassium nitrate(III) till acid reaction is obtained (the reaction of the solution should be checked using indicator paper). Then add several droplets of Rivanol. Red color appears.

Comments:

Rivanol is a homogeneous mixture at 0.1% concentration. Nitrate(III) ions react with Rivanol forming a color complex (red).

TABLETS FOR HYPERACIDITY

Introductory question:

What are tablets for hyperacidity used for? *It is a medication neutralizing gastric juice.*

What acid is present in stomach? *Hydrochloric acid. Tablets for hyperacidity bind hydrochloric acid present in the stomach.*

Exercise:

Analysis of a label on a package of hyperacidity medication.

Experiment:

Laboratory glassware & equipment, reagents: test tube, glass rod, vinegar, methyl orange, tablets for hyperacidity

Description of the experiment, observations and conclusions:

Add a hyperacidity tablet to a beaker with vinegar (ca. 5 cm^3) and methyl orange; after the tablet is completely dissolved, we observe a change in color of the solution. When there is no change, we add another tablet. Methyl orange is red when added to vinegar. When the tablets are dissolving, color of methyl orange is becoming brighter, and finally it turns orange-yellow.

Comments:

The main component of tablets for hyperacidity (*eg* Alusal) is aluminum hydroxide. The reaction between acid (hydrochloric acid in stomach) and base is a neutralization reaction, leading to a change in reaction of the solution from acidic to neutral. Salt and water are products of this reaction.

VITAMIN C

Introductory question:

What is common name of ascorbic acid? *Vitamin C*

Which food products vitamin C is contained in? *In fresh fruits and vegetables.*

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What we use vitamin C for? *Vitamin C is administered as a supplement in a cold season, in case of lowered immunity, vitamin C deficiency in the diet.*

Exercise:

Analysis of a label on a package of vitamin C

Experiment (1):

Laboratory glassware & equipment, reagents: test tube, water solution of $FeCl_3$, water solution of NH_4SCN, crushed vitamin C

Description of the experiment, observations and conclusions:

Add several droplets of water solution of ammonium thiocyanate to a test tube containing water solution of $FeCl_3$. Then introduce a crushed tablet of vitamin C to it. We observe discoloration of the initial red solution.

Experiment (2):

Laboratory glass & equipment, reagents: beaker, conical flask, measuring cylinder, porcelain mortar with pestle, vitamin C, iodine tincture, solution of starch in hot water, hydrogen peroxide solution

Description of the experiment, observations and conclusions:

Crush a tablet of vitamin C in a mortar with pestle, put the obtained powder to a beaker and dissolve in ca. 25 cm^3 of water. Put ca. 2.5 cm^3 of iodine tincture to a conical flask, then add starch solution to it and pour the dissolved vitamin C out of the beaker to the flask. Add hydrogen peroxide solution measured in the cylinder (ca. 20 cm^3) to the so obtained solution. Put away.

After adding starch to iodine tincture, we obtain a dark blue solution, discoloring after vitamin C and hydrogen peroxide solution has been added (it has turned citreous). After another ten minutes, the solutions have suddenly turned dark blue.

Comments:

L-ascorbic acid, commonly named vitamin C, is an organic compound with molecular formula of $C_6H_8O_6$.

MEDICAL CARBON

Introductory question:

Do you know what medical carbon is? Do you know what is it used for?

Medical carbon is used in diarrheas and flatulence, and in drug poisoning or other chemical substance poisoning.

Exercise:

Analysis of a label on a package of medical carbon

Experiment:

Laboratory glassware & equipment, reagents: little jar with a lid, water, pen ink cartridge, crushed tablets of medical carbon

Description of the experiment, observations and conclusions:

Fill the jar with water; pour the ink from the cartridge to the jar and put crushed tablets (at least 5-7) of medical carbon to it. After the lid is fastened, shake the jar vigorously. Repeat the operation at least 2 times. We observe discoloration of ink.

To adjust the plan of the above presented workshop to the older groups of teenagers, we can enrich it with some extra elements, such as Matura revision exercises or experimental ways of solving a research problem and, above all, every experiment

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presented above can be discussed in the light of physical or chemical processes (writing down the conclusion in the form of an appropriate chemical equation).

While solving these examples of tasks the teacher has a chance to draw students' attention to the most common mistakes that appear in Matura exams.

During designing the experiment which will create the possibility to gain the answer to the stated question/problem, some relevant issues have to be taken into account. We, the teachers decide about the form of the workshop suitable for the appropriate activities based on different types of scientific inquiry. The success of such a workshop depends on: a) guided inquiry (students in groups carry out their own experiments based on problem and goal pointed by the teacher, b) bounded inquiry (students plan and carry out the experiments themselves) or c) open inquiry (students propose the way to find the solution to the problem stated themselves) [10]. The essential issue is to draw students' attention to the controlled and uncontrolled factors and dependent and independent variables of a particular experiment; which variables will influence the result of the experiment the most, how the controlled factors should be set in order to get optimal result. It is worth to remind about the significance of control test, about the perseverance of parameters/ fixed factors in the course of experiment.

Selected school revision exercises for final exam are presented below:

1. Is it true that: „Starch turn dark blue in the presence of iodine. The process consists in adsorption of iodine molecules on amylose". Justify your answer.

2. Iodine tincture is an alcoholic solution of iodine (7%) and potassium iodide (3%). Calculate, how many grams of iodine and potassium iodide on should weigh and how much ethanol (density: 0.76 g/cm^3) should be measured off in order to obtain 20 g of iodine tincture.

3. In the Material Safety Data Sheet for 30% water solution of hydrogen peroxide, one may find, among others, density of the solution (20ºC) d = 1.11 g/cm^3 and pictograms:

A. What do these pictograms mean?
B. Calculate mass of hydrogen peroxide contained in 150 cm^3 of this solution.

4. Calculate volume of oxygen under normal conditions, liberated during decomposition of $3.01 \cdot 10^{23}$ molecules of hydrogen peroxide.

5. Write down electronic formula of hydrogen peroxide molecule.

6. Propose an example of homogeneous catalysis and heterogeneous catalysis.

7. How salicylic acid may be obtained from carbide and any simple chemical substances? Write down a sequence of chemical reactions, noting the conditions necessary for them to occur.

8. May two substances present in the system: phenol and salicylic acid be distinguished using characteristic reaction with water solution of iron(III) chloride? Justify your answer.

9. Propose at least three methods of synthesis of magnesium sulfate(VI), starting from simple chemical substances.

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10. Basing on VSEPR method, define the shape of SO_4^{2-} ion, providing type of hybridization of valence orbitals of sulfur atom.
11. Name at least two other methods of magnesium sulfate(VI) synthesis.
12. Analyzing the information provided on a packaging of rivanol: „100 g of solution contains 100 mg of ethacridine lactate", calculate percentage concentration of this solution.
13. Vitamin C is called ascorbic acid. D isomer of vitamin C is biologically inactive, contrary to L isomer. Write down formulas of both isomers.
14. Knowing that carbon atoms have sp^2 hybridization state in graphite, and sp^3 hybridization state in diamond, explain why:
a) graphite conducts electricity,
b) diamond is very hard?

Selected **scientific questions for workshops** for school students are presented below:
1. Does digestion of starch start in oral cavity?
2. Does an active form of catalase exist and is existence of an inactive form of catalase possible?
3. Does the price of a drug influence its effectiveness?
4. Is vitamin C present in fruits and vegetables?
5. Does medical carbon - similarly to active carbon - have sorption properties?
6. Is rivanol harmful for animals?
7. May pH of a bitter salt solution be harmful for our digestive system?
8. May salicylic acid solution be an effective degreaser?

Conclusions

Chemistry is a vital part of our life. It is obvious that we can find chemistry in a daily life in the kitchen [11], in the food we eat, the air we breathe, in our soup, our emotions, and literally in every object we can see and touch.

The well-organized, properly realized workshops give the children and school students attractive possibilities to discover and learn science spontaneously and naturally, invent and build their own creativity. During those workshops children are exposed to situations that arouse their curiosity towards natural processes.

When it comes to children, the proposed workshop uses their natural curiosity about the world, their willingness to pose questions, and at the same time gives the children ability to develop their scientific interests. The following elements are integral: learning by playing in comfortable atmosphere which guarantees acceptance, developing the fundamental skills with the application of the natural knowledge.

In case of older group of teenagers (junior high school and secondary school students), the workshop proposed above gives the ability to develop the fundamental skills, which are described in the core curriculum for general education [4]. The objectives of these activities are to promote positive attitudes toward science and chemistry, help school students develop confidence in their ability to learn and create a proper environment that encouraged students to involve themselves successfully in teaching - learning process [12, 13].

The workshops appeared to be very attractive and effective and provided some real examples of chemical processes [14].

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WARSZTATY PRZYRODNICZE I ICH ROLA W ROZBUDZANIU ZAINTERESOWAŃ PRZYRODNICZYCH DZIECI I UCZNIÓW

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Abstrakt: Rozwijanie zainteresowań przyrodniczych ucznia jest jednym z podstawowych elementów codziennej pracy nauczyciela. Poszukiwanie interesujących rozwiązań dydaktycznych i ich umiejętne oraz właściwe zastosowanie w procesie nauczania-uczenia się pozwala pobudzać i rozwijać te zainteresowania, jak również osiągnąć wiele celów dydaktycznych tego procesu. Jedną z takich propozycji jest nieformalne nauczanie w trakcie różnorodnych spotkań warsztatowych, zajęć pozalekcyjnych czy też aktywnego uczestnictwa w festiwalach nauki.

Słowa kluczowe: nauka, metody nauczania, eksperymenty, umiejętności kluczowe, warsztaty

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