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DETECTION OF SUGAR CONTENT IN FRUIT – CHEMICAL EXPERIMENTS IN KINDERGARTEN

Abstract. Nazaruk Stanisława, Klim-Klimaszewska Anna, *Detection of Sugar Content in Fruit – Chemical Experiments in Kindergarten* [Określanie zawartości cukru w owocach – doświadczenia chemiczne w przedszkolu]. Studia Edukacyjne nr 58, 2020, Poznań 2020, pp. 263-277. Adam Mickiewicz University Press. ISSN 1233-6688. DOI: 10.14746/se.2020.58.14

Experiments carried out by children are highly instructive adventures that develop interest in science. Nothing motivates a child to learn physics or chemistry more than experimentation. Supervised by their teachers, using safe reagents, chemical glass, and other equipment required to conduct experiments, "Little Scientists" discover the laws of physics and chemistry. Experimenting favors a search for answers to the most basic questions; it helps children see the magic of science and discover the secrets of the world around them. Contrary to the common opinion, holding that physical or chemical experiments may be introduced at the beginning of primary school at the earliest, preschool-age children are already prepared for such activities.
The article presents a chemical experiment concerning sugar detection conducted by 6-year-olds. Research was performed to determine whether making chemical experiments has an impact on the level of children's knowledge about sugars. The study included 20 children who carried out chemical experiments in four parallel groups. The level of knowledge was tested twice: first prior to the experiment and then following the experiment. The analysis of the data obtained demonstrated that after the experiment the level of children's knowledge about sugars increased significantly, as evidenced by the t-Student Test outcomes.

Key words: child, kindergarten, knowledge, skills, chemical experiments

Introduction

It is believed that chemical experiments are not allowed until children are at the early education stage, i.e. at the age of 7 to 12. At this age, specific thinking is crystallizing, subject to a variety of external and internal influences.[1] Developing thinking processes encompass an increasingly objective approach to various phenomena (child egocentricity is starting to disappear), operations and interior actions are created, awareness of thinking activities and their socialization is rising, providing the ability to discuss, to justify one's own opinion, and thus, to think discursively and be capable of intellectual exchanges.[2]

Nonetheless, preschool-age children (3-6 y.) possess natural curiosity to figure out how the world functions. Since birth, children are inquisitive explorers and discoverers. They learn through action, experiencing with all their senses. Children at this age are known for high mental activity. The thinking processes of 3-year-olds are situational in nature, directly related to action, and associated with a given moment and what comes with it. This is known as the sensorimotor thinking. The following stage, typical of the preschool age, is concrete-imaginary thinking. Children are able to perform intellectual operations that escape the here and now. Imagination becomes more and more involved in the process. Gradually, children begin to form the rudiments of abstract, verbal-logical thinking. Cognitive curiosity is born, as demonstrated by questions directed at adults, exploratory games, observations of the environment and nature, and great interest in didactic games.[3]

The underlying form of a preschool child's activity is playing. It is thanks to playing that the child discovers the world and social relations, shapes his mind and effective operation skills, satisfies his need to be active, establishes positive emotional states, and eases emotional tension. There is a number of diverse games and activities characteristic of the preschool age. One of them are research games and plays. They are intended to develop child's mental skills, arouse his interests, acquire new experience, explore the world, and enrich his knowledge by autonomous exploratory activities. The key role

[1] J. Bartska, *Gimnastyka mózgu* [Brain gymnastics], Edukacja i Dialog, 2004, 4, p. 21-26; R.A. Cummins, *Sensory Integration and Learning Disabilities: Ayres' Factor Analyses Reappraised*, Journal of Learning Disabilities, 1991, 24(93), p. 160-168.doi.org/ 10.1177/002221949102400304; A.I. Brzezińska, K. Appelt, *Psychologia rozwoju człowieka* [Human development psychology], Gdańsk 2015.

[2] B. Woynarowska et al., *Biomedyczne podstawy kształcenia i wychowania* [Biomedical foundations education and upbringing], Warszawa 2010; N. Wolański, *Rozwój biologiczny człowieka* [The biological development of man], Warszawa 2012.

[3] A. Klim-Klimaszewska, *Pedagogika przedszkolna. Nowa podstawa programowa* [Preschool pedagogy. New basis curriculum], Warszawa 2010.

in these games is played by child's intuition, whereas continuous confrontation with the reality allows one to shape the image of the world. At the age of 5 to 6, children figure out the rules of conduct, invent their own ones, show increasing interest in scientific knowledge. Research games allow children to focus on a single element of the reality around and, subsequently, to direct their attention to its sensory and aesthetic aspects. The objective of such games and activities is to present and solve problems. They must let the child seek, discover and create, thus – acquire accessible knowledge. This is to unleash children's inherent potential, such as the ability to observe, order, qualify, discern mutual relations, imagine, create, form hypotheses. and experiment. Children perform experiments individually and autonomously, but under the supervision of teachers, looking for solutions and getting to the root of the problem.[4]

The core preschool curriculum currently binding in Poland accounts for the contents relating to inanimate nature and children's technical experience (J. of Laws, of 24/02/2017, Item 356).[5] Nevertheless, it is reckoned that experiments related to domains such as physics or chemistry are too difficult for preschool-age children. With a view to the fact that examination, observation, and exploration of inherent characteristics of things and phenomena are associated with tension, which yields satisfaction and happiness with getting to know something, discovering something, arriving at a conclusion, which stimulates the child to think, search, and above all – to act, explain, and draw conclusions, to seek interdependencies, determine the causes and effects, to develop new intellectual operations, such as analysis, synthesis, comparison, generalisation, and which develops perseverance, attention span and perceptiveness, we ought to focus on the fact that teachers need to use experiments and engage children in them as part of their educational and didactic work. This call is supported by the following arguments: children wish to explore, discover their interest, function within a community, think about their future.[6] To encourage children to explore, motivate them to learn, it is crucial that appropriate measures and various methods of showing them the world are employed – starting with those most familiar to the child, most easily

[4] Ibidem.

[5] Rozporządzenie Ministra Edukacji Narodowej z 14 lutego 2017 r. w sprawie podstawy programowej wychowania przedszkolnego oraz podstawy programowej kształcenia ogólnego dla szkoły podstawowej (DzU z 24 lutego 2017, poz. 356) [Regulation of the Minister of National Education of 14 February 2017 on the core curriculum of pre-school education and the core curriculum of general education for primary school (Journal of Laws of 24 February 2017, item 356)].

[6] D. Braun, *Badanie i odkrywanie świata z dziećmi* [Studying and exploring the world with children], Kielce 2002; A. Budniak, *Edukacja społeczno-przyrodnicza dzieci w wieku przedszkolnym i wczesnoszkolnym*. [Social and environmental education of preschool children], Kraków 2009.

apprehended, so that information and skills gained can become an integral component of children's knowledge.[7]

Experimenting as a method of teaching-learning allows children to observe a given process or chemical, natural, physical phenomenon, etc. in their real form and course, under experimental conditions prearranged for that purpose. The application of experiment in the process of education is particularly useful whenever a researched phenomenon or process cannot be viewed directly, due to its complexity, duration, or inaccessibility for direct observation. Therefore, with the intention to observe phenomena and processes, such chemical, natural, physical, challenging to capture under natural conditions, it is induced in an artificial manner, i.e. through trial and experiments. When experimenting, children may follow the phenomenon and attempt to answer the following questions: how does it work? how does it occur?[8] Experimenting provides an opportunity to become familiar with scientific theories and concepts, allowing one to account for and understand the observed or performed phenomena and processes.

Here, we ought to underpin the role of the teacher in the conduct of experiments, who should refer to the child's inherent knowledge and locate it in various areas of scientific knowledge, so that a child can note the difference between them. This will make the child see that his experience to date is often common knowledge and – for it to be genuine and useful – it must be confirmed with the application of verified scientific sources.[9]

In the methodological procedure, the teacher favours approaching the child as a subject who knows something already and who can, on such basis, expand his knowledge. This is related to child's interests and motivation to undertake, and to omit, certain activities.[10] Since early childhood, children discover the rights and relations they cannot, at first, determine and name. The teacher is the person who should help the child develop concepts, explain relationships, while continuously referring to child's experience. Such knowledge may become a foundation for scientific adventures and own initiatives, for if something grasps children's attention, it will suffice to give them an opportunity to develop and confirm the importance of their actions.

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[7] G. Fragkiadaki, K. Ravanis, *Preschool children's mental representations of cloud*s, Journal of Baltic Science Education, 2015, 14(2), p. 20-35; S. Gatt, L. Armeni, *Pri-Sci-Net – A Project Promoting Inquiry-based Learning in Primary Science: Experiences of Young Children Inquiring*, Literacy Information and Computer Education Journal (LICEJ), 2014, 5(2).

[8] F. Biddulph, D. Symington, R. Osborne, *The place of children's questions in primary science education*, Research in Science & Technological Education, 1986, 4(1), p. 77-88; H. Gasiul, *Teorie emocji i motywacji* [Theories of emotions and motivation], Warszawa 2007.

[9] R. Gelman, K. Brenneman, *Science learning pathways for young children*, Early Childhood Research Quarterly, 2004, 19(1), p. 150-158.

[10] H. Gasiul, *Teorie emocji i motywacji.*

The contemporary preschool is required to organise educational situations which will unleash curiosity, inspire them to seek solutions in new directions guided by their interest, free their investigative nature, leave them a free choice of questions and searches, help them see that everything is in a state of flux.[11]

Numerous specialists in the field have emphasised the choice of didactic methods in the process of child teaching-learning.[12] Amongst the activating methods, which ought to be used in the education of preschool children, are methods involving experiment-making, including chemical experiments; their performance provides added value to children, develops their research approach, encourages them to develop their interests and passions, and may help choose a profession later on in life.[13]

To justify the choice of the undertaken research, it must be said that its objective was to examine the relation of learning a selection of chemical issues by 6-year-olds by conducting a chemical experiment. Research comprised the location of experiment, active participation of children, even the time spent performing and observing experiments, which might affect the level of knowledge and skills.

With a view to the importance of chemical education in the life of children, not only those at preschool age, both now and in the future, and accounting for the fact of the absence of this absorbing issue, we should reckon that there is a justified reason for conducting research of that type.

The main purpose of the study was to determine the impact of chemical experiments on the level of knowledge about sugars among 6-year-olds. The objective was further broken down to four specific objectives:

1. The provision of a pre-test to determine children's knowledge about sugars prior to the experiment.

2. The evaluation of the level of knowledge about sugars following the chemical experiment on the basis of the post-test results.

3. The comparison of the post-test results with the pre-test results and noting differences, both significant and non-significant statistically.

4. The development of guidance for effective chemical education in preschool practice.

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[11] R. Gelman, K. Brenneman, *Science learning pathways*, p. 160-162.

[12] M. Kampeza et al., *The expansion thermometer in preschoolers' thinking*, Journal of Baltic Science Education, 2016, 15(2); L. Gallegos-Cazares, F. Flores-Camacho, E. Calderon-Canales, *Preschool science learning: The construction of representations and explanations about colour, shadows, light and images*, Review of Science, Mathematics and ICT Education, 2009, 3(1), p. 49-73; H. Seker, *Will the constructivist approach employed in science teaching change the "grammar" of schooling?* Journal of Baltic Science Education, 2008, 7(3), p. 175-184.

[13] S. Gatt, L. Armeni, *Pri-Sci-Net – A Project Promoting Inquiry-based Learning in Primary Science*.

Methodology of Research

This research forms a part of educational research on chemical knowledge and skills of preschool children. It is an issue which needs to be investigated in Poland, for there has been no research in the field to date. In addition, effectively implemented chemical education in preschools, in the group of 6-year-olds, is bound to be of advantage at further education stages. Due to the set objectives, the method of knowledge tests was applied in the study.

Procedure and Study Participants

The study was conducted between April and May 2017 in Przedszkole Samorządowe Nr 11 (Self-Government Preschool No. 11) in Biała Podlaska, Lubelskie Province. The parents expressed their consent for their children to participate in the research project. All 20 children included in the study lived in Biała Podlaska. Both the analysis and the experiment were conducted in four groups of five. The study was two-staged.

Study Stage I

In April 2017, the first stage of the study was carried out – it encompassed running a pre-test on the group of children (20 individuals) in order to diagnose their elementary knowledge about sugars. The test was adapted to the age of the children (6 y.) and the binding preschool education core curriculum (J. of Laws dated 24/02/2017, Item 356). An original test was develop in conformity with the recommendations of didactic measurement by Bolesław Niemierko, containing 7 illustrated handouts with instructions to follow.[14] Each child was to circle the correct answer. Pictures presented on the worksheets showed:

Handout 1. Images of 4 different fruits: a lemon, an apple, a strawberry, an orange;
Handout 2. Images of foodstuffs: water, milk, bread, jam, a candy bar;
Handout 3. Various physical states: loose powder, juice, crystals, jelly, ice;
Handout 4. Various tastes: salty, bitter, sweet, sour;
Handout 5. Importance of sugar for the human body: running, dancing, sleeping, working on the computer;
Handout 6. Situations relating to low blood sugar: feeling hungry, feeling power less/unable to do a job, a person swimming in a pool;
Handout 7. Situations relating to high blood sugar: a person who passed out at a tram stop, a healthy person who is running in a park.

[14] B. Niemierko, *Pomiar wyników kształcenia* [Measurement of teaching outcomes], Warszawa 2000.

The teacher conducting the class elucidated the principles of the test. Test performance was evaluated at either 1 or 0, where 1 was awarded for a correct answer, and 0 was awarded for a wrong or no answer. Each child could collect a maximum of 7 points for the test.

Study Stage II

Children made a chemical experiment entitled "Detecting sugars in fruit" and subsequently took a post-test. Before the experiment, the teacher provided children with a few facts about sugars and explained the purpose of the experiment. She used the following text: *Glucose (dextrose) is a simple sugar, a chemical substance very important for humans, required to live, maintain body temperature, gain strength, e.g. sick people are often administered infusions with glucose. A drop in blood sugar results in a sense of hunger, fainting, whereas too much sugar can lead to diabetes.*

Having listened to the above, the children commenced the chemical experiment. They were introduced to a set of aids, reagents, laboratory glass, and fruit, which were distributed on each lab table. Their safety was ensured – they had gloves and aprons put on. On every table, there were:

– fruit samples: fresh fruit juice, grapes, an apple, a strawberry, and a lemon;

– a control sample of glucose solution in a tube, held on a stand;

– glucose urine test strips;

– watch glasses, to hold the analysed samples;

– Fehling's solution (prepared by combining two separate solutions: Fehling's A and Fehling's B, volumetric ration 1:1);

– tubes with a stand, a utility clamp, an alcohol burner, matches, a pestle and mortar.

Experiment Instructions: Place the test strips in the fruit samples and let them sit for 30 seconds. Note that the strips have turned brown (you can read the sugar level on the strips), which indicates the presence of glucose in fruit. Heat up a tube with smashed fruit and Fehling solution over the burner. Note that brick red sediments have deposited, which indicates the presence of glucose in fruit.

When the experiment was over, the findings were discussed with the children, who formulated conclusions concerning the role and presence of sugars. After a break, a post-test was conducted.

Data Analysis

The analysis of data obtained was based on: 1) pre-test outcome evaluation, 2) post-test outcome evaluation. For each correctly performed task, every child was awarded a maximum of 1 point. Should a child not master a given activity, s/he was awarded 0 points. The statistical analysis was performed in STATISTICA v. 10. To compare the post-test results with those of the pre-test, a t-Student Test for dependent samples was run. The same statistical test was used to calculate the differences between the accuracy of test task performance.

Results of Research

The analysis of correct answers to individual questions in the pre-test conducted during the first stage of the study are presented in Table 1.

Table 1

Percentage of correct pre-test answers

Task No.	Group 1	Group 2	Group 3	Group 4	Arithmetic mean %
	Percentage of correct answers				
1	24	27	25	26	25.50
2	5	4	3	4	4.00
3	9	11	12	11	10.75
4	26	28	23	29	26.50
5	0	2	2	0	1.00
6	2	2	0	0	1.00
7	5	5	5	5	5.00
Arithmetic mean	10.14	11.28	10.00	10.71	10.53

The results in Table 1 show which questions were answered correctly, and which were not. The top scores were observed in the answers to questions no. 1 and 4. However, the answers to the remaining questions were mostly wrong. The data obtained with regard to the correctness of task performance allow us to state that children's knowledge about sugars is low. Children associate sugars with sweets, sugar in the form of crystals, sugar they use to sweeten something, and with a sweet taste. If a fruit is sweet, it means it contains sugar. This is what about 25-35% of the population studied thinks about sugars.

Table 2 shows the content of those tasks which only a small rate of children was able to answer correctly.

Table 2

Questions answered correctly by very few children

Task No. in the test	Contents	% of correct answers
2	Which foodstuffs contain the most sugar?	4.00%
5	What is the role of sugars in human body?	1.00%
6	Check a situation relating to low blood sugar	1.00%
7	Check a situation relating to high blood sugar	5.00%

Post-Test Results

The post-test was taken after the children had conducted the chemical experiment and discussed its results with the teacher. The percentage of correct answers to post-test questions are presented in Table 3.

Table 3

Percentage of correct answers – post-test

Task No.	Group 1	Group 2	Group 3	Group 4	Arithmetic mean %
	Percentage of correct answers				
1	95	90	95	90	93.75
2	75	80	81	82	79.25
3	51	52	55	58	55.00
4	88	86	85	88	87.00
5	40	42	42	40	41.00
6	72	62	52	62	61.00
7	75	55	65	55	65.00
Arithmetic mean	70.86	66.72	67.85	67.86	68.85

Clearly, the post-test percentages (Table 3) are much higher than the pre-test data. The observed surge related to all test tasks. It seems, therefore, that both the chemical experiment and the activities of the children and the teacher had a positive impact on the level of children's knowledge about sugars. The children discovered that sugars were found in fruit, and that their contents differed from fruit to fruit: there were fruit with low sugar content (lemons), and high sugar contents (strawberries). An analogous situation regarded foodstuffs we consume, not always paying attention to the fact that they contain sugars. Until that day, 6-year-old children had not realised the role sugars play in the human body and why we eat different foodstuffs.

Comparison of Correct Answers – Pre-Test vs Post-Test

The analysis of the outcomes (of both pre– and post-test) raised a question as to whether these differences were statistically significant. To arrive at a conclusion, a t-Student Test for dependent samples was applied. The statistical analysis was performed with a view of identifying differences between the groups and between individual test tasks.

Table 4

Mean pre– and post-test results by groups

Test		Group 1	Group 2	Group 3	Group 4	Total
Pre-test	mean	10.14	11.29	10.00	10.71	10.54
	SD	10.54	11.48	10.30	12.08	11.06
Post-test	mean	70.86	66.71	67.86	67.86	68.86
	SD	19.40	18.61	19.57	19.01	18.71
T-Test for dependent samples	t	11.63	11.45	11.06	11.97	12.40
	p	0.00002*	0.00003*	0.00003*	0.00002*	0.00002*

mean – arithmetic mean; SD – standard deviation; t – t-Student Test value for dependent samples, p – test probability,
* – significant variability at $p < 0.05$.

In all analysed cases, statistically significant differenced were evidenced.

Table 5

Mean pre– and post-test results by task no.

Test		Task No.							
		1	2	3	4	5	6	7	Total
Pre -test	mean	25.50	4.00	10.75	26.50	1.00	1.00	5.00	10.53
	SD	1.29	0.82	1.26	2.65	1.15	1.15	0.00	0.59

Post -test	mean	92.50	79.50	54.00	86.75	41.00	62.00	62.50	68.32
	SD	2.89	3.11	3.16	1.50	1.15	8.16	9.57	1.77
T-Test for de- pen- dent sam- ples	t	32.82	39.88	32.89	58.45	30.80	16.50	12.01	52.54
	p	0.00006*	0.00004*	0.00006*	0.00001*	0.00006*	0.00048*	0.0012*	0.00002*

mean – arithmetic mean; sd – standard deviation; t – t-Student Test value for dependent samples; p – test probability,
* – significant variability at $p < 0.05$.

In all analysed cases, statistically significant differenced were detected.

Discussion

Given the above test results and their analysis, it is challenging to refer to other research or studies conducted in Polish kindergartens. The Polish Institute for Educational Research in Warsaw (*Instytut Badań Edukacyjnych*), which deals with all-Poland educational research at all levels of education, until this day has not administered the performance of such studies. Therefore, it is worth underpinning the following Report from the study entitled *The use of experiments and activation methods in teaching – problems and challenges,* developed by the Research Department, the Copernicus Science Centre in Warsaw (*Centrum Nauki Kopernik*), presenting the use of scientific experiments and trials in the process of teaching-learning by primary school teachers.[15]

Report's data demonstrates that a vast majority of science teachers in primary schools (teachers of Chemistry, Physics, Biology) follows a traditional model of education based on the principle of communicating theoretical knowledge (an essay, course book work, watching educational materials); students learn to a lesser extent by autonomous conclusion drawing through empirical experience. There is little emphasis on individual interpretation and use of experiments. The quoted Report listed difficulties which, in the opinion of primary school teachers, limit the ability to organize classes with the application of experiments. Teachers enumerated: lack of didactic aids to make experiments, ill-equipped classrooms, numerous classes, technical and

[15] Raport, *Wykorzystanie eksperymentów i metod aktywizujących w nauczaniu – problemy i wyzwania* [Application of experiments and activation methods in the teaching process – problems and challenges], Warszawa 2009.

administrative problems, unpredictability of pupils, difficulties with estimating the time needed for a given experiment.

The Report underlines that even though teachers can see the benefit of conducting experiments, they typically make experiments on their own, in the form of a show. This is the easiest and most convenient manner of experimenting for them, and it requires the least work on their part. On the other hand, there are some teachers who conduct experiments together with students, who assist them. Least frequently teachers would allow students to make experiments on their own, individually, which stems from the above mentioned limitations. Despite the seemingly unoptimistic future in terms of carrying out experiments in schools, we must say that it does not stop all teachers from being active – quite to the contrary, they encourage some of them to face new challenges in the field. One example could be KNOW Research Centre in Cracow (Centrum Badawcze KNOW), where young scientists completed a research project, the main aim of which was to arouse interest in chemistry, to popularize chemistry, or even make one fascinated with chemistry, starting at the age of seven. The project was to engage students and make them familiar with selected physical and chemical characteristics of ingredients and simple chemical compounds commonly used every day, such as vinegar, baking soda, and the like. A simple experiment with the participation of children aged 7-13 was conducted in two primary schools in Poland: one in the Małopolskie Province, and the other in the Świętokrzyskie Province. Children's knowledge was verified with a preliminary test, and another test following chemical experiments. In the opinion of the authors of the project, first chemical experiment may be of a great advantage to children, not only in their future chemical education, but also in the study of other parts of science.[16]

Of the European studies in the field, we should list research conducted in Patras in Greece on the population of preschool children, where a thermometer was employed as a familiar and commonly used tool. Through experiments children created scientific concepts in the context of physical and technical phenomena. Research revealed that some children could, on the basis of experiments made, associate thermometer construction with its function. Nonetheless, the majority of the children found it difficult. This made the authors of the experiment to conclude that teachers should note and appreciate the use of simple tools in practice – tools not always associated with science.[17]

Yet another example is a transformation in the approach to teaching children presented on the basis of an experiment involving seeing light as an

[16] M.K. Krzeczkowska et al., *The first chemical experiments in my life,* Edukacja Biologiczna i Środowiskowa, 2015, 3.

[17] M. Kampeza et al., *The expansion thermometer*.

autonomous unit. Light units are represented as a source of light in the minds of 6-7-year-old children. Children's perception of said phenomenon changed after the experiment.[18]

Clouds are a wonderful illustration of getting to know natural physical phenomena the children encounter on an everyday basis. One experiment allowed children to see clouds as autonomous physical entities.[19]

A considerable number of specialists emphasises that little children education must and should involve experimenting, scientific trials. Here, it ought to be underpinned that in the process some regularity must be accounted for: i.e. one needs to start with discovering objects, phenomena, chemical substances present in child's nearest environment. Therefore, the issues presented herein, i.e. simple sugars discovered through a chemical experiment, are consistent with the depicted concepts of experts, both from Poland and abroad.

Another issue worth considering is that the search for reasonable and effective forms of learning refers not only to children but to all levels of education, including university students. Interesting research amongst the students of Biology, training to become teachers, was conducted by Cem Gercek in Turkey. He diagnosed the difficult approach to teaching about the synthesis of proteins, both in the theoretical and methodological sense.[20]

Conclusions

Pursuant to the analysis of empirical materials, conclusions were drawn which will be conducive to the preparation and organisation of didactic work with preschool children, especially in the groups of 6-year-olds. The post-test scores demonstrated a significant increase in chemical skills and knowledge when compared to the results of the pre-test. Said growth was found both in the division by groups and by tasks, which were calculated with the application of the t-Student Test. Based on the results of the employed statistical test, it was determined that the differences were statistically significant. They prove the accuracy of the thesis that the learning process which engages children through making experiments has a positive impact on one's chemical knowledge – children acquire difficult chemical terms in a clear, comprehensible manner, associated with the surrounding environment and usefulness in life. Apart from scientific exploration, children discovered sugars through

[18] V. Ntalakoura, K. Ravanis, *Changing preschool children's Representations of light: A scratch based teaching approach*, Journal of Baltic Science Education, 2014, 13(2).

[19] G. Fragkiadaki, K. Ravanis, *Preschool children's mental representation*s, p. 20-35.

[20] C. Gercek, *Prospective teachers' cognitive structures concerning protein synthesis and their degree of understanding*, Journal of Baltic Science Education, 2018, 17(1).

their senses, i.e. in a sensory manner, which constitutes an additional factor consolidating chemical knowledge.

Conducting chemical experiments is related to learning effectiveness. Children get involved with the making of experiments, ask questions, look for answers, and this motivates them to learn and is an argument directed at teachers: this type of methods ought to be used as often as possible during didactic and educational activities in preschool.

The authors of the article are aware of the fact that presented issues do not cover all aspects of the vast subject matter of experiments in preschool education. This requires further research as the results presented herein were obtained on the basis of a pilot group of children only. Nevertheless, satisfaction derived from the study inspires to carry out more detailed scientific research.

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