REFERENCIA: Lulek, B. (2020). Experimental cognition of the world by children. Unexploited opportunities of Polish Primary Schools. *ENSAYOS, Revista de la Facultad de Educación de Albacete, 35*(2). Enlace web: http://www.revista.uclm.es/index.php/ensayos - Consultada en fecha (dd-mm-aaaa)

EXPERIMENTAL COGNITION OF THE WORLD BY CHILDREN. UNEXPLOITED OPPORTUNITIES OF POLISH PRIMARY SCHOOLS

ACERCA DEL CONOCIMIENTO EXPERIMENTAL DEL MUNDO POR PARTE DE LOS ALUMNOS. POSIBILIDADES NO APROVECHADAS DE LA ESCUELA PRIMARIA POLACA

Barbara Lulek
blulek@ur.edu.pl

Institute of Pedagogy. University of Rzeszów (Poland)

Recibido: 23/04/2020
Aceptado: 27/12/2020

Abstract:

School, particularly primary school, plays a special and unique role in education. It joins teachers and students together, in order to show children and youths the complex reality of the world. Educational processes implemented in the following institution can reflect knowledge transmission or can be based on transaction models. Education is stimulating, experimental and exploratory as it guides students to the world of forming questions, searching for answers and developing conclusions. Unfortunately, this model is rather uncommon in Polish primary schools. This publication presents how experimenting, used by teachers, could introduce 7-year-old students in the first grade of primary school, into the world of knowledge and natural science competence. It also shows how experimenting affects the level of students' education and natural science competence.

The research aimed for describing methods of experimenting with first grade students in science education as well as explaining the connection between applying experiments in science education and students' level of skills and knowledge.

The research used a method of pedagogical experiment - quasi-experimental testing based on initial and final measurement using practical tests. The study included 307 primary school first-graders. The studies have established that there are dependencies between experimenting in science education as well as knowledge and skills level among the first grade primary school students, taking into account subjects' gender. At the end, conclusions were also drawn regarding the possibilities for more extensive use of experimentation in Polish schools.

Key words: experimenting, primary school, 7-year-old child, studying

Resumen:

La escuela, especialmente la primaria, desempeña un papel especial y único en la educación humana. Es un lugar de encuentro del alumno y maestro, durante el cual los niños y jóvenes conocen la compleja realidad del mundo real. El proceso educativo llevado a cabo en dicha institución puede referirse a la transmisión de conocimiento o basarse en un modelo transaccional. El carácter estimulante, investigador y exploratorio de la educación llevan al

estudiante al mundo de formulación de preguntas, busca de respuestas y formulación de conclusiones. Desgraciadamente, este modelo no está muy difundido en la escuela primaria polaca. Este estudio presenta las posibilidades de utilizar la experimentación del maestro con los alumnos como una forma de introducir al alumno del primero de la escuela primaria (niños de 7 años) en el mundo del conocimiento y las habilidades en ciencias naturales, así como el impacto de la experimentación en el proceso didáctico sobre el nivel de conocimiento y habilidades en ciencias naturales de los alumnos.

El objetivo de las investigaciones fue describir las formas de experimentar con los alumnos del primero en el proceso de educación en ciencias naturales y explicar la relación entre el uso de la experimentación en el proceso de la educación en ciencias naturales y el nivel de conocimientos y habilidades de los alumnos.

En las investigaciones se utilizó el método del experimento pedagógico, investigación cuasi-experimental, basada en la medición inicial y final con el uso de pruebas de las actividades prácticas. Las investigaciones abarcaron un grupo de 307 alumnos del primero de la primaria.

En el curso de las investigaciones se estableció la existencia de una relación entre el uso de la experimentación en la educación en ciencias naturales y el nivel de conocimientos y habilidades de los alumnos del primero, tomando en consideración el sexo de los encuestados. También se formularon las conclusiones sobre la posibilidad de un uso más amplio de la experimentación en la escuela polaca.

Palabras clave: escuela primaria, aprendizaje, niño de 7 años, experimentación

1. Introduction

Understood as an active process influencing and developing man's life abilities (Kwieciński & Śliwerski, 2003), based on gaining and passing knowledge, forming abilities as well as learning the values (Szafenberg, 1997), education is fulfilled by various entities -institutions, social groups and individuals. Systematic and planned educational activities in Polish educational system are fulfilled by various types of primary and secondary schools including vocational, technical and general school. Less planned activities are fulfilled beyond the walls of multi-stage school, in peer groups, neighbours' communities or cultural messages.

A compulsory 8-year primary school has been a fundamental cell of Polish educational system since 2017. Children start their school education at the age of 7. The purpose of school is to gradually introduce knowledge to children, prepare pupils to fulfill their duties and accustom them with self-development. School creates a safe environment and friendly atmosphere for studying, providing for individual and educational needs of students. Most significant educational objective in primary school is a care for integrative biological, cognitive, emotional, social and moral development (Regulation of the Minister of National Education, 2017). Educational path in primary school is divided into two stages. The first one covers early education - grade level from I to III, where all lessons and activities are taken by one teacher. Early school education is integrated and based on unified reception of surrounding reality by a child, who recognises the world as a whole, in the cognitive process and only later extinguishes various branches of knowledge through analysis (Więckowski, 2000). Integrated education in forms I to III is based on triggering free, multi-directional activeness of a child focused on student's development as a person (Lulek & Reczek-Zymróz, 2014). The results in a descriptive form, current as well as end-of-term ones, are very important in early school education, which

allow for presenting a certain level of knowledge and child's intellectual, physical, social and emotional abilities as a whole (ibid).

Subject-based teaching, implemented in grades level IV to VIII by teachers who specialise in certain fields, is the second stage of primary school. This level of education covers the following lessons: Polish language, English language, geography, biology, history, mathematics, music education, art, physical education, IT, technical education, lessons with class teacher and religious education or ethics - however that subject depends on parents perforations. Also, from the VII grade second modern language, physics and chemistry, safety education and civics. Students are assessed with a scale of six grades, from 1 to 6, where 6 is the best grade (A - excellent).

The effective core curriculum in primary schools, recommends applying active methods of educating, emphasises the role of research activity among students and appeals to experimenting, observing and experience as fundamental components of teachers' work with students. Legislators also emphasise the connotation of project method with possibility to integrate the class as well as to allow children to manage the process of education on their own. Unfortunately, this positive image of recommended educational solutions in Polish schools is minimised with indication that educational activity in school is determined by the set of school curricula (Regulation of the Minister of National Education, 2017), which strictly regulate issues to be implemented by teachers, thus forcing them to come back to program-centric pattern of education (Kluz – Stańska, 2017), often culturally inadequate. The result of such actions is that implementing project methods or stimulating research and exploration activities, is left on the margin of nomenclature, typology and fractographic material processed by students. In turn, formulated goals indicating verbalism and passive reception are dominant. Therefore, students describe, point, list and name but hardly ever discover, examine, experiment or discuss (Kluz-Stańska, 2017).

Such boundary conditions make it very hard and sometimes even impossible for Polish primary schools to widely spread and use the model of education which emphasises the educational process itself rather than results, research procedures rather than factographic material and education is based on students' activity, learning through acting and discovering (ibid).

All steps such as awakening cognitive enthusiasm, curiosity and motivation for being active, learning through discovering and creative expression leads students to believe they are competent, build their confidence, trust towards the environment and develop the ability to cooperate (Brzezińska, 2000). What is more, learning through acting encourages development of logical thinking, also in the field of building typology and classifying, ranking objects, comprehending state of things and phenomena' reversibility and irreversibility as well as formulating problems and deducing (Schaffer, 2014). These are the natural conditions which enable us to introduce students to the world of collecting knowledge through experiments.

2. Primary school students learn the world through experiments - theoretical fundamentals

Experimenting, observing and experiencing are typical activities for science education which is in primary school mainly about understanding natural environment, human vital functions, protecting health, safety and relaxation as well as understanding geographical areas. Unfortunately, the detailed records in primary school core curriculum which concern using experiments are quite deficient - the term experimentation was only referred to five times (Regulation of the Minister of National Education, 2017). And so, guidelines relating to science education for grades I to III determine that students run simple plants raising, they can also plan and handle basing observations, experimentations and experiments relating to natural objects and phenomena. Moreover, students can work out their notes including their deductions from

observations, pointing to cause and effect connections (Regulation of the Minister of National Education, 2017). The core curriculum connected to geography includes records which state that students are able to observe the watercourse or shoreline of a lake. The lawmaker also suggests outdoor activities on forestial educational trails or meetings with foresters (ibid, pp. 116-117).

At the same time, the part of core curriculum about biology concentrates on emphasising the differences between experimentations and observations or determining conditions for experimental procedures. Unfortunately, there are no suggestions of typical experiments to perform. Chemistry in the core curriculum is treated as an experimental subject, which however has no justifications in particular requirements. Students are mainly expected to define, name, describe or to match-up.

Detailed requirements in the core curriculum referring to educational content in physics emphasises the necessity to illustrate some of the phenomena with experiments. However, it is quite visible that only two or three topics out of a dozen or so, in the whole section require experiments (ibid, 150-159).

This is a highly unfavourable condition because experimenting, experiencing and observing in the educational process allows students to fully understand the surrounding world, it is a starting point to reasoning based on deduction (Puchała, 2012). Applying experiments, observations and experiencing in the process of education makes students engaged and devoted, makes it easier for the students to formulate research questions as well as introduces children to the concluding process which guarantees that the knowledge connected to the surrounding world is permanent.

There are several ways teachers could refer to the mentioned processes in school's training practice. A. Giza-Poleszczuk, when running research among teachers and students together with his team (report published by team members Ł. Krzyżanowska, M. Wiśnicka), extinguished five approaches to experimenting in didactic processes. They are as follows: an experiment shown by a teacher, performing an experiment by teachers and students together (student are treated as teacher's assistants), setting an experiment for homework, students perform experiments in groups during lessons, individually performed experiments during lessons (Krzyżanowska & Wiśnicka, 2009). Using an experimentation method during lessons requires a thorough choice of the tests and experiments proposed for teachers and students, with consideration of participants' safety, how difficult the research activity should be and adjusting experiments to students' abilities and the length of lessons. Performing experiments with students requires formulating research questions, making hypotheses, sequencing of actions, forming conclusions as well as strengthening your knowledge and using it in further studies (Sawicki, 1997). Thanks to experimenting, students can exchange opinions, discuss, analyse gathered material. Teacher's role is to direct it in such a way that students are able to answer formulated research questions on their own. This is introducing a child - student to the world of natural phenomena, discovering the rules which regulate the phenomena, gathering knowledge and bringing it face to face with information from other sources.

3. Research objectives and problems

Guided by the above premises and being convinced about advantages of experimenting method used by teachers and students in the didactic process, I ran my own research aiming at achieving essential objectives of the research (Babbie, 2007, pp. 110-113):

- Exploration connected with desire to get to know experimenting areas of first class students' in primary school and the opportunities for teaching which come with experimentation in the field of natural knowledge;

- Description concentrating on showing the characteristics of first class students experiments in the field of science education, activities, behaviours and emotions accompanying 7-year-old children;

- Explanation deriving from a tendency for further description of phenomena and pursuit to answer the question why it is the way it is (Palka, 2011, p. 157) as well as to measure and discover the cause and effect connections. In the course of the research, my pursuit was to determine how experiments influence knowledge and natural abilities of 7-year-old children.

The research, results of which were presented in this study, were undertaken in order to determine the influence of a particular method on students' natural knowledge level but also to popularise applied solutions among primary school teachers. In this particular context, research results may be applied to specific situations in practice when teaching science. The need to combine the training program with practical solutions was highlighted by J.S. Brotman and F. M. Morre (2008).

At the beginning of the research I formulated the following research questions: if the level of scientific knowledge and abilities among 7-year-old children (I grade students of primary school), depends on learning scientific knowledge through the experimenting method, and if yes, to what extent?

3.1. Research methods

Method used in the research is pedagogical experiment - one group technique. Quasi-experimental research based on pre-posed projects has been used. The research includes initial measurement (before students started to participate in experimental lessons) and final measurements (after completing the project). Variable - knowledge and scientific skills of students has been measured. The measurements were based on conversation, practical tests (Bereźnicki, 2007, p. 417). The survey was carried out by the project's author in the presence of a teacher working with the student. The meetings were held in the training room. During the meeting with a 7-year-old student, the author was reading the task of a scientific experiment, which the student was then carrying out. There were all necessary tools to conduct the experiment, lying on the table. Results were noted down in the individual student's skills assessment card. The next step included formulating collective statistics. There were a few reasons to choose this kind of solution. Main reason was that 7-year-old students' reading and writing abilities are quite poor, that is why the author of this study decided to read the instruction to students. Thanks to the day-to-day teacher's presence the child felt safe and made the measurement a natural element of a teaching process. During classes, the subjects were accompanied by positive emotions related to joy and happiness. The study was conducted in similar conditions for all students, with identical tasks to be resolved, and evaluated according to clear and precise criteria, which were established prior to launching the project, based on a detailed analysis of core curriculum. This document specifies that a first-grader is able to perform a simple scientific experiment, formulate conclusions and observations in the course of experimentation as well as understands the relationship between natural environment components. Moreover, in order to establish a detailed procedure of implementing science education's core curriculum, the author analysed books for first-graders available in the market. This was the basis for identifying tasks measuring skills and elaborating student skills assessments card.

The measurement wa tested in five areas defined as follows: students are able to carry out the experiment on their own according to given instructions, students can explain the conditions under which phenomena introduced to them occur, students are able to name correctly the

objects used in the experiment and phenomena studied, students make relevant observations and conclusions, participate actively in research activities. Students' knowledge and skills were evaluated using a three-level scale, with the following steps: 1 – did not reach the condition under examination, 2 – partially reached the condition under examination, 3 – reached the condition under examination.

3.2. Participants

The study was conducted on the basis of a project by the author, entitled 'Creative children - in search of individuality' (Project No. POWR.03.01.00-IP.08-00-UMO/17), targeted at children aged 7 (primary school pupils - first grade), funded by the National Center for Research and Development. The studies carried out in the course of the school year 2018/2019 involved 307 pupils from the first grade of primary school (7-year-old children), 143 girls and 164 boys. Random selection was used in the studies. Students from primary schools in Podkarpackie Province, Krosno City, were included in the research (south-east Poland).

The study group of first grade students (divided into 17 workshop groups) participated in a cycle of five meetings from the experiments area, which lasted 90 minutes (2 hours of study) once a month. The activities were carried out under the slogan In the sun and rain. Looking for a rainbow and experimental exploration of the world. During this course, students learn the properties of water and light, magnetic field, and chemical reactions. These issues form a coherent program from the field of science and mathematical education, in which children perform experiments, create hypotheses and determine their veracity. The project is based on three ways of experimenting with students: the teacher performs an experiment with students who act as experimenter's assistants, students carry out the experiment according to instructions given to the task group, and students carry out the study themselves. Each of the five meetings with class students included the following types of experimentation.

4. Experimenting as learning through acting - results of research

In the teaching process, primary school students acquire knowledge and develop skills. These tasks are not easy because it is impossible to transfer knowledge directly to the student's mind. Learning from the explanations of the teacher, only designs in the student's mind the ability to "reproduce somebody else's knowledge", while self-production of knowledge happens in the course of their learning activities (Ledzińska & Czerniawska, 2011, p. 6), they equip individuals with the ability to build it (Kluz-Stańska, 2010, p. 484). Not only does the student come into direct contact with the test reality, but in the process of experimenting functions as a working entity that builds knowledge in a number of thinking operations (Parczewska, 2005, p.7; Kruk, 2011, pp. 498-500). In the course of the author's research, first grade primary school pupils were put in a task situation, which consisted of conducting an experience on their own, in a task group or in the presence of the teacher. The level of students' knowledge and skills in the field of natural knowledge was studied on the basis of a three-stage scale, as described above. On the basis of practical empirical evidence collected during students' oral test, their proficiency indicators have been calculated, using the following formula:

$$W_s = \frac{(k_m \cdot n_1) + (k_{m-1} \cdot n_2) + (k_{m-2} \cdot n_3) + \square + (k_1 \cdot n_m)}{N}$$

Where: n1, n2, n3…nn- stand for the subtotals of various ranges,

N- the total number of children tested,

km - numerical value of the scale steps.

Table 1. Impact of experimentation on the knowledge and science skills level of first grade primary school pupils – summary of initial and final research results

Field tested	Scale	Initial measurement results N=307								Final measurement results N=307							
		Girls N=143				Boys N=164				Girls N=143				Boys N=164			
		l.b.	%	point	level	l.b.	%	point	level	l.b.	%	point	level	l.b.	%	point	level
able to carry out the experiment according to the given instructions,	1	98	68,5	98	1,44	112	68,3	112	1,45	5	3,5	5	2,81	3	1,8	3	2,73
	2	27	18,9	54		30	18,3	60		17	11,9	34		38	23,2	76	
	3	18	12,6	54		22	13,4	66		121	84,6	363		123	75,0	369	
total	-	143	100	206	-	164	100	238	-	143	100	402	-	164	100	448	-
can explain the conditions under which certain phenomena occur	1	67	46,9	67	1,68	72	43,9	72	1,70	1	0,7	1	2,81	-	-	-	2,84
	2	54	37,8	108		68	41,5	136		25	17,5	50		27	16,5	54	
	3	22	15,3	66		24	14,6	72		117	81,8	351		137	83,5	411	
total	-	143	100	241	-	164	100	-	-	143	100	402	-	164	100	465	-
names correctly the objects used in the experiment and tested phenomena	1	63	44,1	63	1,76	43	26,2	43	1,95	-	-	-	2,78	-	-	-	2,93
	2	51	35,6	102		85	51,8	170		32	22,4	64		12	7,3	24	
	3	29	20,3	87		36	22,0	108		111	77,6	333		152	92,7	456	
total	-	143	100	252	-	164	100	321	-	143	100	397	-	164	100	480	-
makes good observations and conclusions	1	104	72,7	104	1,36	90	54,9	90	1,57	3	2,1	3	2,69	-	-	-	2,90
	2	27	18,9	54		54	32,9	108		38	26,6	76		17	10,4	34	
	3	12	8,4	36		20	12,2	60		102	71,3	306		147	89,6	441	
total	-	143	100	194	-	164	100	258	-	143	100	385	-	164	100	475	-
actively participates in research activities	1	33	23,1	33	2,01	40	24,4	40	2,01	-	-	-	2,98	-	-	-	2,97
	2	75	52,4	150		82	50,0	164		2	1,4	4		4	2,4	8	
	3	35	24,5	105		42	25,6	126		141	98,6	423		160	97,6	480	
total	-	143	100	288	-	164	100	330	-	143	100	427	-	164	100	488	-

Source: Author's own development, 95% statistical significance of the solution used with the variable gender was noted (t=2,957 for girls i t=15,07 for boys) and for the total number of subjects (t=13,89)

On this basis, the categories of the indicator expressing first grade primary school students' level of science knowledge and skills were also identified. These steps are as follows: 1.00 to 1.66 for a low degree; 1.67 to 2.33 for an average degree; 2.34 to 3.0 for a high degree. See the table below for general data.

The empirical data collected indicates varying levels of knowledge and science skills among first-class students prior to taking part in the experiment. In the first and fourth measuring areas, low levels of knowledge and skills were found (the initial measurement). As many as 68.4% of all surveyed students were unable to conduct experimentation according to the instructions. While over 18% carried out these activities partly. The study established the level of ability to carry out the experiments according to the manual, which was 1,44 and 1,45 among girls and boys respectively. In the area of making accurate observations and conclusions, as many as 72,7% of tested girls performed the initial test task incorrectly. In the boys' group this rate is 54,9%. The initial level of forming true observations and conclusions, determined among girls and boys' groups was 1,27 and 1,57 respectively. Students have shown clear difficulties in formulating research questions and the need for the teacher to channel children activities.

Tested 7-year-old students dealt much better with an area that requires naming objects and conditions. They were able to name correctly the objects used in the experimentation and the phenomena investigated at medium level. In the group of boys surveyed, a noted level was 1,95 and in the group of girls 1,76. There was a slight correlation between gender and the level of abilities in terminology used in the experiment for objects and phenomena (empirical value Chi2 = 11,72, theoretical value Chi2 = 11,72, presumed with 95% probability). There was a difference noted between girls and boys in terms of forming accurate observations and conclusions. The initial measurement showed the ability at 1,36 level anong girls and 1,57 among boys and there also was a slight correlation between gender and the level of abilities in forming correct observations and conclusions (empirical value Chi2=10,54, theoretical value Chi2=5,99, presumed with 95% probability). In the initial measurement there also was an average skill level for both boys and girls (indicator 2.01) under active participating in research activities.

The final measurement results were significantly higher in each of the designated areas. Only a few students, 8 out of the 307, were unable to complete the experiment on their own and only 3 individuals from the total number of tested students were unable to draw conclusions in the course of experiment proceedings analysis. In the first tested area - self-testing according to instructions given, the following percentages have been set: 84,6% of surveyed girls and 75% of surveyed boys are fully able to conduct the experiment. The skill level of the girls being tested is high - 2.81. Skills have increased by 1,37. In the group of tested boys, the skills level is also high although slightly lower, it is 2,73. Skills have increased in the boys' group by 1,28. A minor statistical data has been found in the final measurement, between gender and carrying out an experiment independently according to given instruction (empirical value Chi2=6,65, theoretical value Chi2=5,99, pursued with 95% probability).

In another tested area - the subject can explain the conditions under which some phenomena occur - the final measurement showed the following results: girls - 2.81 (high level), boys - 2.84 (high level). A similar increase was observed between the groups surveyed.

The third tested area connected to correct classification of tools used in the experiment, the following results were established: girls as well as boys achieved high levels (a numerical indicator 2,78 and 2,93 respectively). Boys reached a higher final numerical indicator than girls - just as in the initial measurement. There was a slight statistical dependence in the final measurement between gender and applying correct terminology towards tools used in the experimentation (empirical value Chi2=13,58, theoretical value Chi2=5,99, presumed with 95% probability).

Forming correct observations and conclusions by students was also subjected to final measurement (fourth field tested). The final level of abilities among surveyed girls in this field was 2,69 and among boys 2,9. As in the above, this field also noted a slight statistical relationship between gender and forming correct observations and conclusions by surveyed students (empirical value Chi2=13,45, theoretical value Chi2=5,99, presumed with 95% probability).

In the tested field of active participating in research activities, there was the lowest increase observed. The difference between final and initial measurement was 0,97 and 0,96 both in the boys and girls group. Searching for the answer to this research question, there was a reference made to parametric statistical tests in order to determine the impact of experimentation on the pupils' level of knowledge and scientific skills in statistically significant categories. The T-student test was used in this respect (Lewicki, 1998, pp. 67-73) and with 95% of probability, the experiment-based solution significantly increases the level of knowledge and scientific skills of first grade students (theoretical distribution for df =4, t=2,776, empirical distribution for the same parameters t =13,89).

5. Discussing test results

Empirical data have shown that there is a relationship between applying experimentation as well as the level of knowledge and scientific skills of primary school first grade students. The empirical data obtained correspond to the results of T. Parczewska, who by using activation methods, including experimenting with third grade primary school pupils, noted a considerable increase in children's interest in science and high indicators in understanding cause and effect relationships and the overall level of knowledge and science skills among pupils (Parczewska, 2005). Similar research results were obtained by I. Zioło (2002) who described the application of experiments in classes I-III.

Gender appeared to be a factor differentiating experimental activities of 7-year-old children in the following fields: conducting the experiment individually according to the given instructions, using proper terms for items applied in experiments as well as forming accurate observations and conclusions. In the first of these areas, girls examined had a higher ratio than boys. As indicated by J.S. Bortman and F. M. Moore (2008) this study shows differences between girls and boys. Girls have a deep conceptual understanding and active educational experience. They also seek a deep conceptual understanding and reject routine learning (p. 982). The differences between boys and girls in teaching scientific knowledge are also emphasized by C. Schreiner and S. Sjøberg (2010).

The study found that students were interested in participating actively in experimental lessons (skills level for students in the initial measurement, both boys and girls, is average - 2,01. In the final measurement, boys, similarly to girls achieved a high level of numerical indicator, which was 2,98). The author of the study noticed the surveyed students were demonstrating children's curiosity and focus on activity. The author's results are concurrent with those obtained by M. Tyszkowa (1990, p.6), who emphasizes the students' desire to act and experiment.

5.1. Deduction

The research presented in this study does not cover the whole problem of experimentation as a way of learning scientific reality by pupils however, they allow the following conclusions to be drawn. Research activity of the first grade primary school pupils, their participation in activities based on self-experimentation, or performing experiments in small groups (3-4 pupils), allow for learning in action as well as increases students' level of knowledge and skills.

There was a noted increase in the level of 7-year-old children skills in each tested field. Comparing the results of initial and final measurements, there has been a significant increase in skill levels in three areas: ability to explain conditions in which natural phenomena are formed (the difference in levels between the initial and final measurements is 1.14), forming accurate observations and conclusions (1,33 ratio) as well as carrying out the experiment individually according to the instruction given (1,28 ratio).

Surveyed girls were better than boys in carrying out the experiment according to the instruction given, in the final measurement.

Obtained test results confirm that participation of students in additional classes based on experimentation, affects the knowledge and scientific skills of pupils in primary school in a statistically significant way (95% probability assumption).

6. Conclusion

Learning by action is a fundamental way of education for human beings (Tyszkowa, 1990) since based on experience, individuals learn new areas of functioning in the social environment. This is a natural way to explore the world especially during childhood.

It is worth pointing out that experimentation meets the natural need for children's creativity, an effective surprise to ask questions and building respect for original and interesting solutions (Szuścik, 2013). It encourages cognitive enthusiasm, curiosity and motivations to learn, not only in school reality but also in everyday life.

Students' experimenting refers to experience as a dominant way to explore the world in the natural context (Brzezińska, 1994), acquiring new information and skills in the course of practical performance. Participants of classes based on experimentations are able to use the elements of analysis and synthesis in the learning process as well as for classifying, comparing and concluding (Parczewska, 2005).

Obtained empirical material as well as the analysis of core curriculum for Polish primary schools authorises the closure of the study with the proposal for more extensive use of experimentation by teachers and students in school education as a way of introducing children and young people into creative discovery of the world of nature.

Bibliography:

Babbie, E. (2007). *Social research in practice*. Warsaw: PWN.

Bereźnicki, F. (2007). *The basics of teaching.* Cracow: Impuls.

Bortman, J.S., &Moore, F. M. (2008). Girls and science: A review of four themes in the science education literaturę. *Journal of Research in Science Teaching*. 45(9), 971-1002.

Brzezińska, A. (1994). In the eyes of a psychologist. Education through active participation. *Education and Dialogues*, 9 (62), pp. 22-26.

Brzezińska, A. (2000). *Social psychology of development.* Warsaw: Scholar.

Gerrig, R. J., & Zimbardo, P. G. (2006). *Psychology and life.* New edition. Warsaw: PWN.

Klus-Stańska, D. (2017). Notes to the core curriculum for general education in primary school. *Rocznik Pedagogiczny*, 40, pp.71-87.

Klus-Stańska, D. (2010). *Teaching facing the chaos of concepts and events.* Warsaw: PWN.

Kruk, J. (2011*).* Searching for interactive teaching resources, [in:] D. Klus-Stańska, D. Bronk, & A. Malenda (edit.). *Pedagogy of early education* (pp. 497-506) Warsaw: Wydawnictwo Akademickie Żak.

Krzyżanowska, Ł., & Wiśnicka, M. (2009). *Use of experiments and activation methods in teaching – problems and challenges. Study report.* Warsaw: Pracownia Badań i Innowacji Społecznych Stocznia.

Kwieciński, Z., & Śliwerski, B. (2003). *Pedagogy.* vol. 1, Warsaw: PWN.

Ledzińska, M., & Czerniawska, E. (2011). *Psychology of teaching. Cognitive recognition.* Warsaw: PWN.

Lewicki, C. (1998). *A set of tasks from the statistics for educators*. Rzeszów: Fosze.

Lulek, B., & Reczek-Zymróz Ł. (2014*). Family and School in a changing learning space. Transition time dilemmas.* Rzeszów: Bonus Liber.

Palka, S. (2011). *The basis for pedagogical research methodologies*. Gdańsk: GWP.

Parczewska, T. (2005). *Activating methods in the science education of pupils in I to III grades.* Lublin: Wydawnictwo UMCS.

Puchała, C. (2012). The opportunities for developing students' research attitudes on science lessons, [in:] I. Maciejowska, & E. Odrowąż (edit.). *Education of science subjects shapes students' research attitudes and skills* (s. 31-47). Cracow: UJ.

Regulation of the Minister of National Education from 14 February 2017 on the core curriculum for pre-school education and the core curriculum for general education in primary school (2017). *Journal of Laws,* (356), 1-315.

Sawicki, M. (1997). *Environmental education in primary school classes I-III.* Warsaw: Semper.

Schaffer, H. R. (2014). *Child psychology.* Warsaw: PWN.

Schreiner, C., & Sjøberg, S. (2010). *The ROSE project An overview and key findings*. Oslo: University of Oslo, (March), 1–31. Retrieved from http://www.uv.uio.no/ils/english/research/projects/rose/publications/the-rose-project.pdf

Szarfenberg, R. (1997). An educational issue, [in:] A. Rajkiewicz, J. Supińska, & M. Księżopolski (edit.), *Social policy* (pp. 145-153). Katowice: Instytut Pracy i Spraw Socjalnych

Szuścik, U. (2013). The work of the child in the light of selected psychology concepts and pedagogical concepts of creativity. [in:] A. M. Żukowska (edit.). *Educational and therapeutic aspects of art.* (s. 14-23). Lublin: Wydawnictwo UMCS.

Tyszkowa, M. (1990). *Activity of children and young people.* Warsaw: WSiP.

Więckowski, R. (2000). *Early school education in the context of the reform of the school system.* Piotrków Trybunalski: Wydawnictwo Naukowe Akademii Świętokrzyskiej.

Zioło, I. (2002). *Environmental education at the level of integrated education.* Cracow: Wydawnictwo Naukowe Akademii Pedagogicznej.