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Journal of Preschool and Elementary School Education nr 2(2), 115-155

2012

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Introduction

University education has an important role in the development of society, as far as the foundation of new pieces of knowledge is concerned, as well as transferring them to the students by the support of research and innovation. In Europe, there are as many as 4000 university type educational institutions, with more than 19 million students, and as many as 1.5 million university lecturers. According to the European Commission, the number of students studying at universities is insufficient, the study programmes of universities are not often adequate to the needs of the labour market, and these problems are similar in several different EU member states (European Commission, 2011).

The general aims of the European Union in the field of educational policy, which were formulated until the year 2010, pertained to the improvement of the education of teachers, development of key competencies, improvement of the number of students studying natural and technical sciences, improvement of attractiveness of teaching and learning, etc. (Achieving the Lisbon Goal, 2004). Of the particular aims (benchmarks), until 2010 we can mention the following: a 50% decrease in the ratio of males and females who graduate in the field of mathematics, natural sciences and technology (compared to the year 2000), and also ensure a significant growth of graduates of these particular fields of study; furthermore, to decrease by half the ratio of 15-year old pupils, who are attaining only under the average level of natural sciences, mathematics

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and literary literacy; additionally, to make sure that at least 10% of the population at the age of 25–64 years, will participate in the life-long education (Achieving the Lisbon Goal, 2004, p. 21).

An important step, which was taken by the European Union in order to develop natural science education, was the formation of the expert group, the aim of which is to analyse in detail the ongoing initiative in the given field, and from the said research to gain a know-how, which could lead to a fundamental change in the interest of the young people in the study of natural sciences. The report compiled by the expert group summarises the claims of the professionals on the particular topic that the pedagogical approaches based on the so called research-based methods are more efficient than the procedures based on the traditional methods. Nevertheless, in the school practice of the European Union member states, science and research-based methods are not practically realized to a sufficient degree (Science Education NOW).

A great deal of contemporary research proves the idea that the students do not have a sufficient amount of natural-sciences knowledge. An international study titled PISA presents the findings that the level of scientific literacy of Slovak pupils (as well as the pupils in the neighbouring countries) is average or less than average, at the end of their compulsory schooling. This situation is getting worse, since a number of pupils continue their education at secondary schools, with a limited number of classes dedicated to education in natural sciences. Therefore we believe it is important to solve this situation by improving the quality of natural sciences education within university preparation of students, who are preparing for the profession of teachers at nursery schools and elementary schools.

This paper deals with the issue of improving of the level of scientific literacy of students studying the field of pre-school and elementary pedagogy. We propose a concept of education that applies experience-based education, which does not concentrate on the improvement of the breadth of encyclopaedia-based knowledge of students, but mainly aims at the improvement of the level of their ability to work scientifically and experimentally in order to solve difficult problems. We attempted to prove by our research whether adherence to the proposed concept of education has any impact on the improvement of scientific literacy of students. We perceived scientific literacy as a set of various pieces of knowledge, skills and standpoints, which are the prerequisites for the solution of tasks and the situations of everyday life. The proposed concept of education was proven in the practice by pedagogical experiments, the results of which are explained in the paper.

A future improvement of the level of scientific literacy of students studying pre-school and elementary school pedagogy can be perceived as an important task, mainly because of the fact that these students are preparing for the education of children of pre-school age and the pupils of younger school age. According to a number of neuroscientists, the brain reaches top abilities at the age of five years. This is especially true of the period of pre-school and younger school age which are most significant for the development of an individual, for it is at this age that the individual has an open ground for the development of his/her skills and abilities, and if during this critical period such abilities are not developed, particular individuals shall never reach their potential abilities and the individual will never reach the potential that he/she could have (Sousa, 1998; Turek, 2008). It is in this period that we can develop the abilities to work scientifically, which are an indispensible part of scientific literacy, and motivate them to undertake education in natural sciences, which is becoming less and less popular these days. The problem of the inadequate level of scientific literacy of pupils and students lies in the fact that the students acquired only the formal parts of natural sciences education during their previous education. However, one of the most important tasks of the teacher should be to map out the individual pieces of experience of pupils or students and to find out which pieces of knowledge and experience they have acquired by being active during their previous education and extracurricular environment, and to follow up on them in the educational process. When construing a new piece of knowledge, it is very important to verify it, which is only enabled by the replacement of the original pre-concept by the required concept. The appropriate means for such verification include activating educational methods. Information acquired through an activity, and this has an indispensible function in comparison to other kinds of information. Aside from this fact, on the basis of one's own experience, we believe it is more appropriate to make use of independent and group solutions of troublesome situations by the students, while the results and interpretations of the results are presented by the students in written or oral form. Even if the students of the field of study (pre-school and elementary school pedagogy) have developed abstract thinking and have been at the formal and operational level for a long time (according to Piaget), it is important for them to be able to manipulate the objects, study tools, through which they are able to follow various phenomena of the natural sciences.

Outline of basic terms – scientific literacy, natural science education, study field pre-school and elementary school pedagogy

Scientific literacy

The term ***literacy*** has a different meaning in the common language than in the pedagogy. It is generally perceived in connection to the acquisition of the ability to read and write, or come to terms with a trivial literacy. From the point of view of pedagogy, it is a broader term, according to B. Pupala (2000) we can say that "education = literacy", i.e. "the meaning of the term has been shifted and developed". Literacy generally means "an ability of the individual to become adjusted to the environment, manage the requirements of the social and cultural environment, an ability of the individual to survive through one's own literacy" (Held, in Kolláriková, Pupala, 2001, p. 354). We encounter the term literacy along with various adjectives, e.g. *functional literacy, technical literacy, visual or digital literacy*, which altogether form *cultural literacy*. The origin of these and various other terms of literacy is influenced by the fact that "the phenomenon and category of literacy are purely cultural products, their semantic content is shifted along with the changes in culture, so it is a historically changeable term" (Pupala, 2000). Scientific, technological, digital literacy, as well as other kinds of literacy, are " a part of the whole human literacy…" (Pupala, 2000) and can be labelled by a more general term ***cultural literacy***, which "enables an individual to participate in (re)production of cultural values and tools, which join the particular cultural environment" (Pupala, 2000).

According to R. M. Hazen (2002) literacy in natural sciences is a blend of terms, history and philosophy, through which we can understand the scientific problems of contemporary world. Scientific literacy therefore means a broader understanding of the basic terms. It is not only the case of the specialised scientific language of experts. A common human being does not need to know the chemical composition of the newly invented medicaments in order to be certain of the significance of the medical development, nor does he/she need to calculate the orbit of the spaceship to be able to ascertain its significance in space explorations. By a degree of simplification we might say that an individual is literate as far as natural sciences are concerned, if he/she is able to understand research articles in the journals, e.g. dealing with the ozone layer or genetic engineering.

According to the National Science Educational Standards, scientific literacy is composed of the "knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity" (NRC, 1996, p. 22). Stemming from this definition, the scientifically literate person is able to find the answers to the questions, which originated in his/her curiosity, explain and predict natural phenomena, read, understand, and be able to discuss natural topics presented in the media, identify natural topics presenting fundamental information necessary for the creation of national and local decisions, making use of the data and pieces of evidence used for assessing the quality of natural information and arguments presented by the scientists or in the media. M. Their and B. Daviss (2002) define scientific literacy as a set of knowledge about scientific facts and terms associated with the ability to communicate these thoughts through language.

In the OECD PISA study (Programme for International Student Assessment), the term scientific literacy is perceived as "the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity" (National Report PISA SK, 2007, p. 29). Scientific literacy requires a certain degree of reading and mathematical literacy, and it is assessed by the PISA study as one of the key competencies. Acquisition of literacy is a life-long process, which not only takes place at school, during formal schooling, but also through the interaction of the pupil with the parents, schoolmates and the broader community. Therefore, PISA concentrates on the broader understanding of the key terms, and not on the highly specified and specialised pieces of knowledge of particular subjects. The study does not test to what extent the pupils master the studied material prescribed by the curriculum and other pedagogical documents, for knowledge tends to lose its validity very rapidly in the contemporary knowledge-based society. Therefore, it should be constantly changed and supplemented.

Slovakia in the past five years participated in two significant international assessments of the level of scientific literacy – TIMSS in year 2007 and OECD PISA in 2009. In both assessments, we obtained below average results. The reasons for this unsatisfying level of scientific literacy can be found in the natural sciences education in the previous school years compared to other school years, when the pupils were tested. The level of scientific literacy is therefore influenced as early as primary or even pre-primary natural sciences education. Another reason can be found in the teachers, who teach these subjects. Are they themselves at a relevant natural sciences level? What is the quality of their natural sciences education at university?

Natural science education

The fundamental task of ***education*** is in general to pass on to the younger generation the culture of the particular society (Held, in Kolláriková, Pupala, 2001). According to E. Opravilová (1988, p. 17) the idea of education is to "absorb the results of knowledge and experience, which humanity has summarised…" It is because our culture keeps constantly reproducing and the sum of knowledge is constantly on the rise, the requirement to pass on all the information of the younger generation is utterly unimaginable.

"In the period of information explosion, any attempt to reach perfection is utterly hopeless" (Turek, 2006, p. 116). It is impossible, even today, to become familiar with the knowledge of the world, not only in its basic terms. This information explosion creates larger and larger conflict between the limited capacity of the human brain and the ability of the individual to absorb the constantly increasing information (which is changing and becomes obsolete very quickly). Even the encyclopaedias get older more quickly than humans. This conflict can be solved only in such a way that we change the main aim of school education. Instead of passing on a large amount of mainly factual information, school graduates should rather be getting more tangible values and skills, than just mechanically memorised definitions, formulas, dates of birth of famous personalities, etc. (Turek, 2006). Instead of this, they should acquire the key competences (Hlaváčová, 2012), necessary for being able to master the tasks of ordinary life. Generally speaking, the aim of education is to develop the key competencies. From this we can follow the aim of natural sciences education, being the formation of scientific literacy.

Natural sciences education is connected with a set of scientific disciplines, which are referred to as natural sciences. These include the basic natural sciences – physics, chemistry, biology – and the derived natural sciences, e.g. geology, geophysics, meteorology, physical chemistry, biochemistry, mineralogy, etc. The term nature has a number of meanings; therefore we talk about a multi-disciplinary understanding of this term. In the narrowest sense, we are talking about Earth nature without humans and without the products of his or her actions; a broader understanding includes the Earth nature – the Earth, and in the broadest understanding, its universal nature – the Universe (Nový, 1989). In connection with these types and degrees of schools, the aims, content and immaterial means of natural sciences education is changed.

In *pre-primary education*, the issue of natural sciences education is included in the thematic curriculum titled *Nature*, which in its complex perceptual-motoric, cognitive and socially-emotional approach transgresses cognitive and non-cognitive sphere of development of the child (Hajdúková et al., 2011, p. 85). In *primary education*, natural sciences education takes place primarily in the curriculum programme *Nature and Society*, mainly in the subject *Introduction to Biology*. The main aim of the subject is to develop the knowledge of the child in the field of cognition of the natural environment and the phenomena associated with it, so that the child becomes well versed in the information and is able to process it objectively, to the extent which is allowed by his/her cognitive level (ŠVP, Introduction to Biology – appendix ISCED 1, 2011, p. 2). In *lower secondary education*, natural sciences education is undertaken mainly through the curriculum programme *Humans and Nature*. This curriculum programme explains to the pupils the whole set of problems associated with studying of nature. Subjects of the curriculum programme – *biology, physics, chemistry* – put an emphasis on the active forms of the acquisition of knowledge, skills, abilities and competencies necessary for the development of natural sciences literacy (ŠVP ISCED 2). The curriculum programme *Humans and Nature* is included in *higher secondary education at secondary grammar schools*. The curriculum programme *Humans and Nature*, which includes subjects such as *biology, physics and chemistry*, enables pupils to look for legal connections between the observed characteristics of the natural objects and processes, which surround us in everyday life. The aim is not only to lead the pupils towards an understanding of the phenomena taking place in the real world, but also to teach them to think critically, as well as acquire and evaluate information (ŠVP ISCED 3A).

Natural sciences education can be developed not only at schools, but also in various extra-curricular organisations, and through a number of projects. The choice of the university, at which students prepare for their job, depends on the type of the secondary education, or on the extra-curricular education, as well as on the hobbies and other activities of the student. The best prepared students for the study of natural sciences are those who have graduated from secondary grammar schools. In contrast, some secondary schools do not have education in natural sciences. Since a number of students from various secondary schools are enrolled at pedagogical faculties, students with various degrees of elementary pedagogy are included in the study programme pre-school and elementary school pedagogy.

Study in field of pre-school and elementary school pedagogy

In the ***field of pre-school and elementary school pedagogy***, students are prepared for the profession of pre-primary and primary education. The programmes for the education of teachers of pre-primary and primary education are enshrined, in most cases, in university studies in the developed world (Study programme 1.1.5 pre-school and elementary school pedagogy, in the system of fields of study. Accreditation commission, p. 1). In this paper we deal with such study programmes, which prepare the future pedagogues of pre-primary and primary education in the neighbouring nations of Slovakia, i.e. the Czech Republic, Poland, and Hungary.

For example in the Czech Republic, in the field of *předškolní a mimoškolní pedagogika* (Pre-school and elementary school pedagogy), the students have a choice of studying within the Bachelor's study programme preparing teachers for nursery schools. In the field *učitelství pro 1. stupeň ZŠ* (Teaching for primary school), the students have the choice to study in the Master's programme *učitelství pro základní školy* (Teaching for basic school). In Poland, people can prepare for such profession in the following study programmes: *pedagogika przedszkolna i wczesnoszkolna* (Pre-school and elementary school pedagogy), *edukacja przedszkolna i wczesnoszkolna* (Pre-school and elementary school education), *wychowanie przedszkolne i edukacja wczesnoszkolna* (Pre--school upbringing and elementary school education), *edukacja wczesnoszkolna z wychowaniem przedszkolnym* (Elementary education with pre-school upbringing), *pedagogika przedszkolna z rytmiką* (pre-school pedagogy with rhythm), *edukacja wczesnoszkolna z reedukacją* (Elementary education with re-education), *edukacja szkolna* (School education), *edukacja wieku dziecięcego* (Education of childhood), *zintegrowana edukacja wczesnoszkolna i wychowanie przedszkolne* (Integrated elementary education and pre-school upbringing), *zintegrowana edukacja* *wczesnoszkolna i terapia pedagogiczna* (Integrated elementary education and pre-school therapy), *wychowanie przedszkolne* (Pre-school upbringing) and others. In Hungary, the students prepare for the profession of teacher at the pre-primary level of education within the bachelor study programme for nursery schools (Pre-school Teaching) and for the profession of teacher at the primary level of education within bachelor study programme for primary education (Primary School Teaching).

The core of knowledge for the first level (bachelor) of the field of study of pre-school and elementary school pedagogy in Slovakia, in the methodological context it is ordered to include in the curriculum methodology of educational and formative activities in the fundamental spheres of formation and education, including Introduction to Natural Sciences (field of study 1.1.5 pre-school and elementary school pedagogy, in the system of fields of study. Accreditation commission, p. 3). The core of the knowledge for the second level (Masters) of the field of pre-school and elementary school pedagogy has been ordered to include in the curriculum in the pedagogical and psychological context the theory of formation of cultural literacy and in the didactic context the fundamental parts of primary education, including initial natural sciences education (field of study 1.1.5 pre-school and elementary school pedagogy, in system of fields of study. Accreditation commission, p. 4).

On the basis of the accessible information on the web pages of pedagogical faculties and the information acquired from university teachers, we can state that the number of natural sciences oriented subjects in the study programmes of pre-school and elementary school pedagogy at particular pedagogical faculties differs considerably. Sometimes these are two subjects, sometimes ten or more subjects that have a natural sciences flavour. The education of teachers of nursery schools and the junior level of primary schools lacks a national curriculum in Slovakia, as well as in the neighbouring nations; therefore the number of natural disciplines as well as its objectives, content, and means of teaching differ.

Survey of the current level of scientific literacy of students of pre-school and elementary school pedagogy

What is the level of scientific literacy of the students of pre-school and elementary school pedagogy? Within the mentioned research problem we attempted to find out whether the students are able to comprehend the natural sciences topics, whether they are able to professionally explain the natural sciences phenomena, or whether they are able to use scientifically backed facts. From these notions follow further questions: Can the students detect the problem, which is possible to research through scientific means? Can they identify the variables of natural scientific experiments? Can they make use of the natural scientific pieces of knowledge in a given situation? Are they able to describe or interpret natural scientific phenomena, ascertain or estimate their development or changes? Can they interpret scientific facts, draw conclusions, identify assumptions, evidence and causes leading to the outcome, reflect social impact of natural sciences on the development of technologies? (according to: Natural sciences. Tasks 2006, 2008, p. 91).

The aim of the survey was to ascertain the level of the scientific literacy of students of the field of study pre-school and elementary school pedagogy. The overall aim presupposed the following partial aims: find out whether the students are able to comprehend natural sciences topics, find out whether they are able to professionally explain natural scientific phenomena, find out whether they can use scientifically backed facts. In order to achieve the aims of this survey, we also determined the research methods, which included the following: a compilation of tests to determine the level of scientific literacy of students of the field of pre-school and elementary school pedagogy, a determination of the target groups, the undertaking of the collection of data from the respondents, quantifying and describing the acquired data, explaining the results and proposing an improvement on thestatus quo.

We assumed that the students of the study field of pre-school and elementary school pedagogy possessed a below average level of scientific literacy, which is expressed in in tests that scored lower than 50%. We also expected that the students might score higher in tasks relating to the professional explanation of natural scientific phenomena and lowest in solving tasks aimed at understanding of natural scientific topics.

The survey was attended by 369 full-time and part-time students of the field of study pre-school and elementary school pedagogy of 3 pedagogical faculties in Slovakia. In order to ascertain the level of scientific literacy of students of pre-school and elementary school pedagogy we applied the didactic test consisting of 31 tasks and 10 topics. The tasks were intended to demonstrate understanding of natural sciences topics, provide a professional explanation of natural phenomena and apply scientifically proven facts (c.f. Rochovská, 2012).

On average the students scored 40,6% in the test which a below average level of scientific literacy. The highest attained level in the test was 85%, the lowest being 12,5%. In similar surveys of the scientific literacy of students in a similar field of study (Melicherčíková, Melicherčík, 1996; Melicherčíková, 2011) the authors commented on the not very favourable situation which also has its roots in the fact that the majority of students of the field of pre-school and elementary school pedagogy have no secondary grammar school education, i.e. their education of natural sciences was rather limited.

Our expectations regarding results of the survey were proven for the tasks aimed at demonstrating an understanding of natural scientific topics, which were solved on average at 28,58%; the tasks aimed at a professional explanation of natural sciences was 56,27%; and the tasks aimed at the utilisation of scientifically proven facts was 38,27%. The students faced the greatest difficulties when trying to detect problems, which can be researched using scientific means, identifying essential terminology when searching for information and fundamental features – variable natural sciences outcomes. Therefore we believe it is beneficial during the university natural sciences education of the future teachers to stress the development of abilities of the scientific work of the students. We proposed the concept of natural sciences education of students of the field of pre-school and elementary school pedagogy in which we concentrated on the development of the abilities to form research problems, variables, hypotheses and research conclusions. It is mostly through their research work that the students acquire natural sciences knowledge which they will be able to utilise when solving troublesome tasks of the everyday life.

Proposal for the concept of natural sciences education in the field of pre-school and elementary school pedagogy

The aim of the proposed concept of education is to prepare students of the field of pre-school and elementary school pedagogy for their future profession as teachers at nurseries and primary schools, and that they should be literate as far as natural sciences are concerned, i.e. they possess scientific literacy as an inevitable competence necessary for the 21st century, who are motivated to educate themselves constantly in the field of natural sciences and, to this end, they apply the abilities of scientific work. A further aim is to prepare these students in such a way so that they are able to project a formative and educational process of children of pre-school age and junior level of primary schools, which would be efficient from the point of view of developing their scientific literacy and motivation towards natural scientific cognition.

The proposal of the concept stems from an analysis of state of the art of contemporary natural sciences education in the university for the preparation of students studying pre-school and elementary school pedagogy (Rochovská, 2012) and from the above stated research results of scientific literacy. On the basis of the insufficient level of scientific literacy of students (mainly the level of the ability to determine scientifically researchable problems and identify variables of natural sciences research) it is necessary to strengthen their university education, for a very small percentage of them are graduates from secondary grammar schools which means that they only studied natural sciences to a limited degree and possess significant shortcomings in relation to it.

Philosophical aspects of the proposed concept of natural sciences education

Every pedagogical concept has its philosophical context. Within the outline of a philosophical point of departure of the proposed concept of natural sciences education in the field of study pre-school and elementary school pedagogy we will concentrate mainly on one of the four components of philosophy – epistemology. It cannot be unanimously stated what the origin of knowledge is and what its function is in relation to subject – the environment. Of the three main, mutually competitive theories of knowledge – empirism, rationalism, and constructivism – works dealing with the didactics of natural sciences prefer constructivism. The reason is obvious, both empirism and rationalism understand knowledge as being independent of the functioning of human beings in their environment; the epistemology of constructivism perceives cognition " as the consequence of human activity through which it interacts with the environment" (Pupala, in Kolláriková, Pupala, 2001, p. 61).

Ideas about the origin and nature of cognition are essential for the constructivist approach to education. E. von Glasersfeld (1990) describes constructivism as a theory of cognition with its roots in philosophy, psychology and cybernetics. The content of education within a traditional school, both in its static and dynamic mode, gives the students new definite and a priori constructed truths, so it attempts to transfer an unlearned individual into learned one through artificial contents constructed outside of the individual, through which it expresses utter distrust in the individual. On the other hand constructivist perception of formation stems from the category of subjectivity. Its point of departure is the experience, independent cognition which is formed in everyday life situations. The constructivist approach expresses trust in the student by accepting his or her ability to form one's own understanding of phenomena positively transgressing it, creating new meanings, ideas, attitudes and beliefs (Kikušová, Pupala, 1995). The constructivist perception of cognition differs from the traditional one according to which the world exists outside of our control and individuals create copies of reality in our thought. On the contrary, according to the constructivist approach, the individual is aware of what takes place in his/her mind, he/she knows his/her imaginations but the relationship between ideas and knowledge structures is debatable. As stated by Maturana, Varela (1980), and Rorty (2000), there is no "mirror" of nature at the level of receptors which would realise pure mirroring of the environment, only a mosaic of elementary intuitive states which are transformed into experience in the brain. That means that our body does not select the information but constructs it.

The psychological aspects of the proposed concept of natural sciences education

The psychological point of departure of cognitivistic concepts of development, stemming from the epistemology of constructivism, is cognitivistic psychology, which deals with the processes such as sensual cognition, imagination, fantasy, thinking, memory, learning, including the ability of abstraction, language and attention (Hartl, Hartlová, 2004). It emphasises the fact that cognitive processes are not limited to only scientific cognition but they are applied in everyday life when solving problems and making decisions. People are characterised by natural curiosity, they slowly acquire new and new pieces of knowledge and in this process formulate hypotheses as scientists, verifying or rejecting them (Čáp, Mareš, 2001).

In the cognitivistic approach the subject actively turns to the world on the basis of cognitive schemes which are formed from the influence of the environment on the human being. This approach appears not only in psychology but also in philosophy and contemporary didactics thinking the most influential position (Pupala, 2001). Cognitivistic theories of learning have brought about important pieces of knowledge relating to the influence of the activity of the student when accepting information. They emphasise that learning is an active process in which the individual creates his/her own interpretations of the accepted information, processes them through a transformation into understandable parts and creates one's own meanings of the reality. Cognitivists point out the fact that for efficient learning, the individual not only needs explanation of new facts but mainly an active incorporation in the teaching process through which his/her cognitive and practical skills are developed.

A number of different ideas have been formulated in constructivism. The opinions of J. Piaget have influenced the stream of cognitive constructivism which emphasised the actions taking place in the brain of the student. Social constructivism stemming from the works by L.S. Vygotsky, have concentrated on the social and cultural conditions of learning and social interaction in the mechanism of learning. J. Piaget derives cognition from action which also includes interaction of the subject with physical reality. The concept of L.S. Vygotsky also presents the idea of the semi sphere – an interaction with the symbolic world of human culture and its input into the formation of knowledge. L.S. Vygotsky explains functioning of the human mind through social activities of people; the mind is formed from the symbolic interaction between them. Vygotsky's statements on the social origin of the human psychic lean towards the category of tool and sign, which represent human activity. These are the two aspects of the same phenomenon; the function of the tool is to change the outside world, the function of the sign is to influence at the level of human psychic (Pupala, 2001). It is on the basis of the merging of the two streams that the pedagogical constructivism stems from (Hartl, Hartlová, 2000) or the pedagogical movement constructivist pedagogy which according to J. Průcha (2009) emphasises in education the solving of life problems, creative thinking, manipulation with tools, team work, and less theory and drill.

Constructivist thoughts have a significant impact on the contemporary perception of education. An active role for the student is stressed, who constructs the meanings on the basis of cognitive structures that he/she has already formed. In such a perceived education, it is a case of introducing a certain degree of imbalance between student's already acquired knowledge and knowledge that is yet to be acquired. The teacher introduces problematic situations so that the students can express their own ideas, form questions, debate problems, express their own opinions, form objectives, collect materials, form hypotheses and prove them, draw conclusions, etc. Constructivism emphasises the construction of knowledge of the students and its active task in the process of cognition through one's own actions. Of the theories of constructivist didactics, we can mention the following: the allosteric model of A. Giordan (Giordan, 1989) and epistemological cancellation of M. Larochelle and J. Desautels (1992). The overall characteristics of the said theories has been presented by Y. Bertrand (1998).

Proposal of subjects in the field of pre-school and elementary school pedagogy

On the basis of analysis of the information sheets of natural based sciences and subjects taught at various pedagogical faculties in Slovakia and abroad, we have proposed the subject titled *Introduction to natural sciences with didactics for pre-primary education*, which can be included in the Bachelor's study of pre-school and elementary school pedagogy and the subject *Introduction to natural sciences with didactics for primary education* which can be included into Master's study programme – teaching for primary education. The subjects include the subject part which develops the scientific literacy of students and the psycho-didactic part which develops the abilities to design formative and educational activities of children and pupils so that their scientific literacy is sufficiently developed.

The objectives of the subject in the Bachelor's study programme are formulated in the following way: "Acquire the ability to design pre-primary natural sciences education and natural sciences club activities as a process of developing the scientific literacy of children, to be able to operate formative and educational objectives in connection with the objectives and to be able to choose appropriate formative and educational methods, strategies, forms and material means. Acquire the ability of self-reflection of the realised natural sciences education at nursery school and in the school club. Acquire the knowledge of natural sciences, ability to work scientifically and the ability to transform them in the process of pre-primary natural sciences education and natural sciences hobbies." (Rochovská, 2012, p. 78).

The objectives of the subject in the Master's study programme are formulated in the following way: "Acquire the ability to design primary natural sciences education and natural sciences club activities as a process of developing the scientific literacy of pupils, to be able to operate formative and educational objectives in connection with the objectives and to be able to choose appropriate formative and educational methods, strategies, forms and material means. Acquire the ability of self-reflection of the realised natural sciences education at junior level in primary schools. Acquire the knowledge of natural sciences, the ability to work scientifically and the ability to transform them in the process of primary education." (Rochovská, 2012, p. 80).

The content of the subject follows from the aims which mainly includes such professional natural scientific topics, which are imbedded in the content standard of the educational sphere Nature in the state educational ISCED 0 – pre-primary education and in the content standard of the educational sphere Nature and Society in the subject Introduction to Natural Sciences in the State education programme for the junior level of primary schools in Slovakia ISCED 1 – primary education. Besides this the topic's content includes the professional didactics with the application to natural sciences education.

We also describe the recommended teaching methods and form which are chosen in connection with the objectives. A number of practical methods are applied by the full-time students directly during the education of the subject and the part-time students undertake more home preparation, and their notes relating to the tasks solution become the subject of assessment. The students are assessed in a professional theoretical part (written examination in natural sciences), a practical part (the solving of experimental problem tasks) and a didactic part (preparation and presentation of natural sciences oriented educational activity/project of the lesson of Introduction to Natural Sciences and self-reflection from projects verification in practice). The information sheets contain basic study literature. The subjects are taught in the Slovak language, and there is also an English-language version that is available to any foreign students that enrol for these subjects.

In the proposed development programme we prepared the topics of the practical education of Introduction to Natural Sciences (simple machines, electrical energy, the Universe). Students of pre-school and elementary school pedagogy emphasized in a number of surveys that these topics were the least popular (e.g. Melicherčíková, Melicherčík, 1996).

Fundamental strategies of the proposed concept of natural sciences education

Fundamental *strategies* of the proposed development programme of natural sciences education of future teachers in nursery schools and junior level of primary schools mainly include the following:

- *constructivist approach to education* – the active role of the student in the process of learning is decisive, which is perceived as the process of cognitive construction. Learning is undertaken through active manipulation with the subjects, their models, rocks, measuring appliances, etc.
- *teaching through the solving of problematic tasks from ordinary life* – learning starts with the updating of the previous knowledge and experience of the students, it is followed by the introduction of problematic situations which support the motivation of students. Students can mutually communicate, advise one another, discuss problems, have arguments which support the social and cultural context.
- *solving of project tasks through experiment* – the students solve project tasks in the form of independent (group) work. The core of the project is to solve the task through experiment, their own stating of the research problem, formulating independent variables, dependent variables, constant variables, acquire tools and material, formulate hypotheses, which are verified by practical activities. The outcomes of the problematic task's solution are presented in written and verbal forms with respective photo documentation or video documentation.

When undertaking experimental education, every topic started with finding out students' notions about the particular issue. The students would express their expectations and their whole study process in a written or verbal form, in the discussion with the teacher. The topic continued by giving the problem task to the students who were supposed to solve it with the application of the recommended and easily accessible tools and materials – full-time students did so during the seminars, part-time students did so during their home preparation for the next class. The proposed problem task required from the students the stating of the research plan in a structure – research problem, variables (independent, dependent, constant), hypotheses, procedure, acceptance or rejection of the hypotheses, and conclusions. Subsequently, mainly part-time students documented their procedure with the use of photographs. Students, besides tools and materials, had at their disposal also educational material (Rochovská, 2012) from which they were able to draw information in case they lacked the necessary information for solving the task. Students were able to find out whether their primary ideas were in accordance with the verified and studied information, and they were able to undertake the reconstruction of their ideas in favour of scientifically acceptable explanations.

After the solution had been performed, there followed the evaluation. Students were given feedback from their teacher regarding their correct or incorrect solution which formed a forum for the reconstruction of their knowledge in case their conclusions were wrong. They were allowed to repeat their experiments and demonstrations (full-time students during their seminars, part-time students during their home preparation).

The teacher completed and specified the theoretical outcomes, emphasised a professional explanation of the phenomena and assigned the students with unspecified tasks in which the students were able to utilise their experience, acquired knowledge and skills. At the end the students were assigned another problem task which was due until the next class.

Results of experimental verification of proposed concept of natural sciences education of students of pre-school and elementary school pedagogy

Aims, tasks and hypotheses of research

The main objective of research was to prove experimentally the efficiency of teaching according to the proposed concept of natural sciences education in the university preparation of students in the field of pre-school and elementary school pedagogy. The following research tasks were derived from research objectives: draft pre-tests and post-tests aimed at determining the level of understanding of the selected natural sciences topics by the respondents, determination of the target groups (survey sample) and a realization of pre-tests, guaranteed realisation of teaching of the selected topics according to the proposed development programme (experimental group), guaranteed realisation of teaching of other topics in the form of traditional lectures and seminars (control group), the undertaking of post-tests, quantification of acquired data, and an explanation of research findings.

We formed the following research hypotheses:

- H_1: We assumed that the level of scientific literacy of students in the field of pre-school and elementary school pedagogy tested by selected diagnostic tools would significantly statistically increase with the application of the proposed concept.
- H_2: We assumed that the level of ability to explain the natural sciences terms and phenomena (in the selected topics) of students in the field of pre-school and elementary school pedagogy tested by selected diagnostic tools would significantly statistically increase with the application of the proposed concept.
- H_3: We assumed that the level of ability to utilise natural sciences pieces of knowledge for the solution of tasks from the everyday life of students in the field of pre-school and elementary school pedagogy tested by selected diagnostic tools would

significantly statistically increase with the application of the proposed concept.

H_4: We assumed that the correctness of the formed variables (during solution of problem tasks by the students in the field of pre-school and elementary school pedagogy) would influence the correctness of the hypotheses forming by students.

H_5: We assumed that the correctness of hypotheses forming (during solution of problem tasks by the students in the field of pre-school and elementary school pedagogy) would influence the correctness of students' conclusions.

Research methods

A number of research methods were applied in the research: pedagogical experiment, didactic tests, analysis of students' work, and questionnaires.

When teaching particular topics students were given the choice of various problem tasks which they solved practically. When assessing the tests their score from practical tasks was included in the score of the experimental group and the score from other tasks was included in the score of the control group. In order to determine the level of scientific literacy before and after the experiment we utilised the *didactic test* which included tasks based on explaining natural sciences terms and phenomena and also tasks based on the utilisation of natural sciences pieces of knowledge when solving tasks from ordinary life. The test was aimed at the topics of simple machines, electric energy and the Universe.

Another research method was *analysis of students' works*. Students were assigned two compulsory tasks of the topics simple machines and electric energy and one voluntary task from the topic the Universe.

In order to determine the opinions of students on natural sciences education based on experienced teaching we used a *questionnaire* which included 14 items, 4 of which were closed, 8 open and 2 semi-closed. We asked them about their content with the curriculum and methods. We also asked them what their most and least appealing lectures were, what in their eyes was beneficial in solving home problem tasks or whether they found the information acquired during their studies unnecessary, and which they believed were the least possibly applicable in practical life. At the end the students were supposed to explain based on their self-evaluation, into which of the 6 levels of scientific literacy determined by the PISA study they belonged before and after studying the subject.

The basic set was formed by all Master's degree students in the field of pre-school and elementary school pedagogy in Slovakia. A selective set was determined by accessible selection. It was impossible to conduct accidental selection, for it was important to work with the study group as a whole. The selective set of the experimental research included a total of 122 part-time students of the first and second years in the Master's study programme of pre-school and elementary school pedagogy for primary education at Pedagogical Faculty, Catholic University in Ružomberok. Part-time students were selected on the basis that there were a greater number of students in the group, but also because of the fact that the teacher of part-time students has decreased the number of his/her classes by one third. It was possible to study the efficiency of the proposed methodology of such students to a greater degree than with full-time students. The extent of selection n was calculated by the formula (according to I. Turek, 1996): $n \geq z^2 . p\,(100 - p) / e^2 \geq n \geq 1{,}962 . 50\,(100 - 50) / 102 \geq 96{,}04$. In the said formula *n* stands for the number of items of the selected set, *z* is the value of selected degree of significance $z_{0,05} = 1{,}96$, *e* is the calculated error (we chose = 10 %) and *p* is the relative number in percent where we put the recommended value p = 50. The experiment was in accordance with the condition of statistical processing and validity at the level of significance $z_{0,05}$.

Interpretation of research results

In order to statistically verify hypotheses $H_1 - H_3$ (which were preceded by the acceptance of hypotheses about normal distribution and number of score in the pre-test and post-test in the experimental and control groups) we used an χ^2 test for the table 2x2. In each and every testing zero and alternative hypotheses were formulated. The observed numbers of the students in the control and experimental groups who did not score better in the pre-test and post-test (minimally by 20%) we entered in the contingent table. From the observed numbers we calculated expected numbers according to the following formula: expected numbers = sum in column / total sum * sum in line.

For determining the level of statistical significance (the so-called p value) CHITEST was applied. The result (achieved level of statistical significance) was compared with the value of 0,05. If the assessed value was lower than 0,05, we rejected the zero hypothesis and accepted its alternative.

Hypothesis H_1 was confirmed at the level of 5% significance. In the experimental and control group there is a significant difference in the number of students whose score in the post-test improved compared to the score in the pre-test (minimally by 20%) and so the level of scientific literacy of students in the field of pre-school and elementary school pedagogy in the experimental group tested by the didactic system statistically significantly increased due to the exercising of the designed concept of natural sciences education compared to the control group.

When the pre-tests were conducted in the experimental group, the students reached the score of 10,89%; the results they obtained in the post-test were a bit higher 16,54% – the difference of the score in the post-test was much greater. In the experimental group the students reached 49,47% which were below average results but the score was much lower in the control group, only some 30,70%. These results are alarming especially when we consider the fact that the respondents were tested in the study materials which is dealt with in primary education, and, moreover, this applied development programme of natural sciences education was not at very high level of difficulty, as it built upon the previous knowledge and experience of the students. It would be beneficial to continue developing the scientific literacy of students. In the physical part of the subject Introduction to Natural Sciences in such a way that they utilised already acquired knowledge, skills and experience when solving unspecified problem tasks.

Hypothesis H_2 was confirmed at the level of 5% significance. In the experimental and control group there is a significant difference in the number of students whose achieved score for the tasks dealing with the explanation of terms and phenomena in the post-test was much higher than in the pre-test (minimally by 20%) and so the level of ability to explain natural sciences terms and phenomena of pre-school and elementary school pedagogy students in the experimental group tested by didactic test increased considerably in comparison with control group.

The pre-test experimental group scored on average 6,7% and in the control group 13,50%. The post-test results were extremely low. The control group scored only 25,38% and the experimental group only 42,62%. Despite this low level of success we can follow some shift in the experimental group and its ability to explain terms and phenomena of natural sciences. These abilities should be further developed by solving practical tasks in which the students should verbalise their procedures and conclusions. Apart from knowledge of the natural sciences and understanding of the given phenomena and terms, further phenomena can influence the solving of tasks such as the verbal abilities of the students, his/her word-stock, etc.

Apart from the overall assessment of the level of understanding of particular terms and phenomena by the students we also concentrated on the comparison and improvement of the level of understanding of terms and phenomena in the pre-test and post-test among the students of experimental and control group. As stated by Ľ. Held, B. Pupala and Ľ. Osuská (1994) in order to follow deeper and more complex subjective processes of cognition and learning we cannot fully rely on quantitative approach. Therefore in order to deal with more individual specific terms of cognition leading to results of a different nature in order to create a more plastic image of the researched situation we completed the quantitatively processed results of our research by its qualitative counterpart. Because of the limited extent of our paper we are unable to publish all our findings. They are accessible in the monograph published within project KEGA of the grant agency of Slovak Ministry of Education (Rochovská, 2012).

In the process of the evaluation of research results, a number of definitions and drawings of simple machines in the pre-test differed only in-detail from the definitions and drawings submitted by the pupils of junior level of primary school conducting similar research (Krupová, Krížová, Melicherčíková, 2009). In the post-test, the experimental group results were of a higher quality but in the control group this shift was minimal or the answers of the respondents were formal, memorised from the textbook. In a number of cases in the control group the answers included definitions from the textbooks for introduction to biology at the junior level of primary school.

The extremely low level of success in the task solving of pre-test and post-test took place when the respondents were asked to define the process of generating electric energy. In this case memorised pieces of knowledge were not sufficient, for this task required also the description of the process, not only the stating of facts. Respondents who experimentally solved the problem tasks about electric energy were unable to manipulate or observe the process of such generation. Despite this fact they were more interested in this type of process, for their experience from experimenting motivated them towards learning; that is why they solved this task with a higher degree of success.

In contrast, the highest degree of success was recorded in solving the tasks about the Solar System. In this case respondents in experimental group practically created the model of the Solar System, manipulated the objects, they directly observed simulated phenomena which resulted in the fact that in the post-test they scored 95,45% of success.

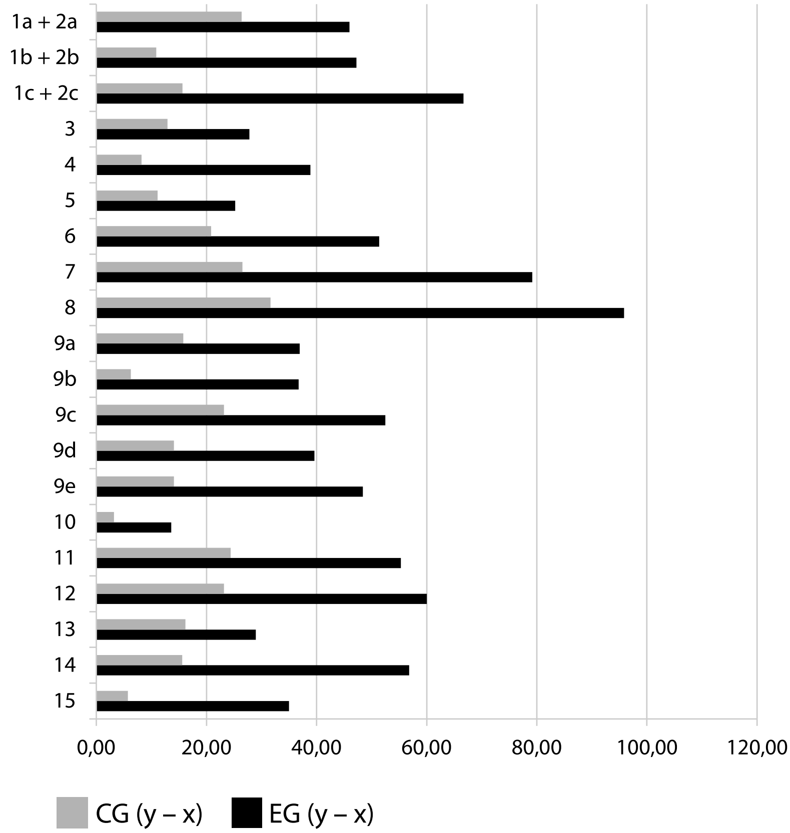
Hypothesis H_3 was verified at the level of 5% of significance. In the experimental and control groups there is a great difference in the number of students whose score in the solving of tasks relating to ordinary life was higher in the post-test compared to their score in pre-test (at least by 20%) and therefore the level of ability to solve problems relating to the ordinary life of students studying pre-school and elementary pedagogy in the experimental group tested by the didactic test through the application of the proposed concept of natural sciences education was statistically significantly increased in comparison to the control group. Similarly, the results of testing the level of ability to solve the tasks from ordinary life of students studying pre-school and elementary pedagogy are also published in the monograph written by the author (Rochovská, 2012).

From the results in Table 1 and Diagram 1 it follows that students in the experimental group achieved a higher increase in score in all tasks than students in control group. Table 1 presents the percentage difference of the score in the post-test and pre-test in the experimental group, in the control group and the increased score in experimental group compared to control group. Unshaded are the tasks aimed at explaining the terms and phenomena, shaded are the tasks aimed at employing knowledge when solving practical tasks.

Table 1: Increase of score in EG (Experimental Group), CG (Control Group) and difference EG – CG

task	EG (y – x)	CG (y – x)	EG – CG
1a + 2a	45,95	26,39	19,56
1b + 2b	47,22	10,88	36,34
1c + 2c	66,67	15,64	51,03
3	27,78	12,93	14,85
4	38,89	8,17	30,72
5	25,22	11,11	14,11
6	51,36	20,83	30,53
7	79,17	26,53	52,64
8	95,83	31,63	64,20
9a	36,91	15,79	21,12
9b	36,72	6,25	30,47
9c	52,50	23,17	29,33
9d	39,59	14,06	25,53
9e	48,40	14,06	34,34
10	13,58	3,18	10,40
11	55,30	24,39	30,91
12	60,00	23,17	36,83
13	28,96	16,16	12,80
14	56,81	15,57	41,24
15	35,00	5,71	29,29
average	47,09	16,28	30,81
median	46,59	15,61	30,50
modus	-	23,17	-
max	95,83	31,63	64,20
min	13,58	3,18	10,40

Diagram 1: Difference of score in post-test (y) and pre-test (x) in experimental (EG) and control group (CG) [%]



The highest increase of a score y – x achieved in experimental group was 95,83% and in control group 31,63%. The lowest increase of score in experimental group was 13,58% and in control group 3,18%.

Tasks in the pre-test were solved with a slightly higher degree of success than the explaining of terms and phenomena. The results of the experimental group were 14,88%, and those of the control group 20,08%. In the post-test, similarly, a higher degree of success was achieved than in the tasks aimed at explaining terms and phenomena. When solving the problem tasks, students in the experimental group scored 58,89% and in the control group 37,54%.

The lowest increase of score in the experimental group compared to the control group was at a task in which the students were to answer the question which of the workers is using a lower force when lifting a load; in one case, the load was lifted without a lever and in the other one with a lever. Despite the fact that students in the experimental group solved the task in a practical way, the increase of their score was 14,85%. This could be the result of wrongly measured data and the insufficient application of tools. They expressed these facts in the questionnaire, namely that the tools caused them major problems. In the next task which had a low increase of score, the respondents were supposed to answer the question how a child accompanied by an adult could enjoy a complex swing. This was not a problem with answers. The respondents would state trivial reasoning or would not provide any at all. It is generally known that students of various types and levels of schools have problems with argumentation. During a previous study (marked by a transmissive approach) they were not sufficiently led to argumentation. It is therefore important to support their argumentative abilities mainly during final presentations and interpretations of the projects. This is easier to undertake with full-time students because of the time management of the subject. With the part-time students there is no time for developing this skill during classical education, therefore we recommend the inclusion of a series of questions into work-sheets as part of home study of the problem tasks, which aim to develop students' argumentation and reasoning, not only their research activities but also their procedure, planning of research, etc. In another task with a low increase of score, respondents provided proposals aimed at saving electricity. This task had the lowest degree of increase of the score in favour of the experimental group, only 12,80%. The result was also influenced by the fact that they had already solved the task in the pretest with a success rate of 18,06% in the experimental group, and 17,35% in the control group. Aside from this, respondents of the control group were able to learn the principles of saving electric energy from the study materials because for this task memorising was sufficient. Nevertheless, learning combined with practical, experimental solutions was more effective and the respondents of the experimental group developed their research skills.

The highest increase of score in favour of the experimental group was recorded in the tasks aimed at friction. In the first task the students were supposed to find out in which position the wardrobe can be shifted easily (placed on a bases with various surfaces) in order to use least strength possible. In another task students were supposed to find out whether during the task of pulling a sledge up the hill the child will be more tired with the rope aligned with the slope, or whether the adult who was pulling the rope at a certain angle would be more tired. For students without any practical experience with solving such tasks, these tasks were unclear. Students of the control group were therefore unable to solve this task in the post-test correctly, as opposed to the students in the experimental group who had sufficient knowledge and practical experience to solve the task correctly.

Overall, in the process of solving tasks aimed at explaining terms and phenomena, the average increase of score was in favour of the experimental group with 29,88% and when solving problem tasks 31,95%, which are comparable data.

We would make the following recommendations for the practice of developing of skills to utilise natural sciences knowledge for solving of practical tasks: students should have a greater opportunity to be able to utilise knowledge and skills acquired in experiments during the solving of other unspecified tasks which would be more difficult than the previous ones, but not so difficult that the students are unable to solve them and lose the sense of success. Learning should be so motivating for them that they are happy to solve the tasks and have a good feeling about acquiring new knowledge and experience.

In our research we concentrated on the analysis of the work of students. In every one of the seven problem tasks the students were supposed to state the research problem, independent variable, dependent variable, constant variable, hypotheses, procedure and conclusions. For every correct item they were given 2 points. For every partly correct item they were given 1 point.

To sum up, students managed to solve the tasks in their work-sheets at 70,15%, which is an above average level. They had sufficient time for solving these tasks (one month for solving tasks relating to simple machines and one month relating to electric energy). They had the possibility of searching for data in the literature or of consulting with each other about the tasks. Students were most successful in the topic of an inclined plane (77,23%); the topic with the lowest success was electric energy (62,64%). Overall, students had fewer problems solving the topic of simple machines than the topic of electric energy. The biggest problem for the students was to formulate the research problem, independent and dependent variables. The least problematic was the description of solving procedure. The solving of the partial tasks is included in Table 2.

Table 2. Solving of problematic tasks by students [%]

	research problem	independent variable	dependent variable	constant variable	hypotheses	procedure	conclusions	total
1	58,33	87,50	79,17	90,27	56,94	76,39	65,28	73,41
2	50,00	69,23	73,08	76,92	80,77	73,08	61,54	69,23
3	79,17	83,33	54,17	58,33	79,17	91,67	95,83	77,38
4	60,42	43,75	62,50	83,33	70,83	91,67	72,92	69,35
5	61,76	64,71	70,59	73,53	64,71	79,41	67,65	68,91
6	46,15	53,85	46,15	61,54	76,92	76,92	76,92	62,64
Σ	59,31	67,06	64,28	73,99	71,56	81,52	73,36	70,15

Legend:

Task 1 What do we need a lever for?
Task 2 How do we lift a weight? (roller)
Task 3 How do we move a weight? (inclined plane)
Task 4 What are electric conductors and semi-conductors? Is water an electric conductor?
Task 5 How does an electric circuit behave?
Task 6 How is electric energy produced?

On the basis of our research results we can confirm hypothesis 4 and hypothesis 5. Hypothesis 4 was confirmed because 62,28% of students formulated both incorrect variables and incorrect hypotheses. Hypothesis H_5 was confirmed because 71,93% of students formulated both incorrect hypotheses and incorrect conclusions.

For statistical verification of hypotheses H4 – H5 we used χ^2 test for the table 2x2.

Hypothesis H_4 was confirmed at the level of 5% of significance. There is no significant difference between the number of students who incorrectly stated variables when solving problem tasks and the number of students who incorrectly stated hypotheses when solving problem tasks. This means that the students of pre-school and elementary pedagogy were influenced by the correct stating of variables and correct formulating of hypotheses when solving the problem tasks.

As early as during research in scientific literacy it was determined that students of pre-school and elementary school pedagogy have problems formulating variables and research hypotheses. In a similar manner, when analysing the work-sheets we came across various mistakes. In order to improve the situation we recommend the inclusion in the process of natural sciences education more tasks which would be solved experimentally.

Hypothesis H_5 was not confirmed at the level of 5% of significance. There is a great difference between the number of students who stated wrong hypotheses when solving problem tasks and the number of students who formulated wrong conclusions when solving problem tasks. It means that the ability of pre-school and elementary school pedagogy students to state hypotheses did not greatly influence the correctness of the formulation of conclusions when solving problem tasks. Students apparently formulated their conclusions on the basis of experiment results and by their own logical reasoning. Hypotheses were formulated only on the basis of abstract thinking. This was more difficult for students than formulating conclusions which stems from practical experience acquired in experiments. The formulation of conclusions on the basis of experiment results and through logical reasoning was apparently simpler than formulating hypotheses on the basis of abstract thinking.

If the students drew incorrect conclusions on the basis of a wrongly conducted experiment they were always given feedback during the following lecture and seminar, and were better motivated to study the topics which they learned about through their own experience. They were able to study information in their materials regarding correct procedure and conclusions from the problem task. Results of their study are supported by their success in the didactic test.

In the end it is important to state evaluation of the designed experimental teaching by the particular students who are the target group of the project. It is important that they have a positive relation to the realised teaching so that they were motivated to be active (we mainly think about their internal motivation, expressed through their joy from learning and discovering). Students said that they were happy with the content of the lectures and with the applied methods. They were mostly content with the topics of experimental teaching and practical methods, mainly the solving of experimental projects, which were beneficial for them and enjoyable. Therefore it would be appropriate for university lecturers teaching natural sciences to gain as many grants as possible within which it would be possible to gain the materials and tools necessary for such experimental teaching. Respondents expressed their opinions that they would appreciate experimental teaching aimed at topics such as plants, animals, rocks and the Universe. The respondents believe that all natural sciences knowledge gained during natural sciences education can be practical in their future life, and most of them believe that the level of scientific literacy would increase by one level when they complete natural sciences education. The research results as well as the respondents themselves speak in favour of natural sciences education based on experience teaching.

Conclusions

Modern society is characterised by the extremely rapid growth of new technologies, information and information sources. Therefore people who want to be successful on the job market should be competent and literate in such an information environment, i.e. they should have the knowledge, skills and abilities adequate for the 21st century. Preparation should begin with pre-primary and primary education, which would help children and pupils from an early age to obtain and develop competences enabling their full participation in life and society. This however requires teachers who are literate for the 21st century, and who have such competences and can give the children and pupils the fundaments of such competences as platforms for their further development.

The aim of education for the 21st century is the development of key competences of children, pupils and students. Such competences stem from Delors (1997) and his generally accepted formulation of education aims – learn to learn, learn to act, learn to live together and learn to be. European programmes for the support of education are united in the aims of education which include the acquisition of key competences, including basic competences in science and technology. On the other hand it can be stated that natural education in Slovakia has been emphasising the compliation and reproduction of theoretical pieces of knowledge more than the essence of scientific research and thinking. According to the opinions of professionals of natural sciences education of younger pupils (e.g. Melicherčíková, Kopáčová, Bernátová, Held, Pupala, Wiegerová, Žoldošová, Čepičková, Podroužek, Šimík, Krížová and others) this process should include such activities enabling the pupils to use the acquired knowledge in new situations which would develop their competences to solve problems.

The task of natural sciences education is to make the children, pupils and students interested in nature and to teach them how to learn about it and research it. In order for the teacher to be able to fulfil such tasks it is important that he/she is motivated to discover nature and has acquired the methods to enable such discovering. Therefore it is necessary for the teachers to develop their own natural scientific cognition through similar methods which are recommended for natural scientific education of children and pupils. If the teachers discover the art of discovery and exploration they will be able to understand the advantages of exercising such activities in the education process of children and pupils.

In the paper we emphasise the implication of a constructivist approach to education. The advantages of such an approach to education are that the student is an active element as opposed to the traditional approach; therefore, the students learn better and with greater interest than in the traditional approach, his/her interests and curiosity are fulfilled, he/she develops his/her thinking and comprehension, this approach will enable better transfer of his/her knowledge, he/she is actively involved in his/her own assessment in which not only the result is assessed but also the process of learning; such students acquire not only knowledge and skills but also some key competences, mainly communication, interpersonal skills and cognition.

We attempted to include the above stated principles in practice during natural sciences education of future teachers in the field of pre-school and elementary school pedagogy. According to E. Petlák (2004) it often happens that such students acquire a great deal of knowledge, e.g. about pedagogical competences, division of methods, forms of teaching; they know the definitions of pedagogical terms but they seem to have very little creativity when it comes to the formative and educational process itself. However according to I. Turek (2008, p. 135), "pedagogical faculties should act as shop windows of modern quality and efficient education". Teachers should be able to apply the most efficient teaching methods, strategies, approaches so that they would be a good example for their students, the future teachers. That is why we included in the proposal of natural sciences education development programme also the practically intended topics – verification of the proposed projects of education activities and the classes in natural sciences practice. Another solution to the topic of the transgression of theory and practice could be the faculty schools, which would enable the inclusion of new formative and educational methods, strategies, approaches and techniques directly into practice, and the students would be able to observe and verify their theoretical knowledge in practice. We include this only as a hypothetical solution and we did not deal with it in our publication, for it is a very difficult solution from the point of view of legislation.

Solving of the topic of natural sciences education of teachers of nursery school and the junior level of primary schools is a broad and difficult topic. It cannot be fully covered within one paper or publication. The author hopes that she has managed to take a humble step forward regarding the topic, and draft some possibilities regarding how to further develop natural sciences literacy of students. By using three topics of the physical part of the introduction to biology – simple machines, electric energy and the Universe we pointed out that by adhering to a constructivist approach to education, the level of ability to solve problems and the level of acquisition of terminology increases. Students also express their positive opinions regarding the realised experimental education. It is for this reason that in the future we plan to analyse further topics using the same principles and create a series of study materials for students of pre-school and elementary pedagogy. We believe that we will be able to open the gate of knowledge for students which they will have to enter themselves.

Acknowledgement:

This paper is published within the KEGA grant scheme KEGA MŠ SR no. 002KU-4-2011 The Issue of Development of Natural Sciences Literacy in the Field of Pre-school and Elementary Pedagogy and the GAPF grant scheme GAPF no. 1/23/2012 Scientific Excursion as Indispensable Part of University Preparation in Field Pre-school and Elementary Pedagogy.

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Abstract:

The main topic of this paper is the issue of the development of scientific literacy of students in the field of pre-school and elementary school pedagogy. The theoretical part is dedicated to outlining basic terms, such as scientific literacy, education in natural sciences, the field of study of pre-school and elementary school pedagogy. It presents the outcomes of research in scientific literacy of students of the field of pre-school and elementary school pedagogy in Slovakia. It analyses the concept of natural sciences education, designs a development programme of natural sciences education in the given study field. At the empirical level, it presents the results of experimental verification of the designed concepts of education and on the basis of research results, it presents recommendations for the educational reality.

Keywords: scientific literacy, natural sciences education, constructivism, cognitivism, pre-school and elementary school pedagogy

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