Vincentas Lamanauskas (Ed.)

SCIENCE AND TECHNOLOGY EDUCATION: ENGAGING THE NEW GENERATION

Proceedings of the 2nd International Baltic Symposium on Science and Technology Education (BalticSTE2017), Šiauliai, 12–15 June, 2017

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NATURAL SCIENCE AND TECHNOLOGY EDUCATION: BalticSTE2017

Vincentas Lamanauskas
Šiauliai University, Lithuania
E-mail: v.lamanauskas@ef.su.lt

Dear Readers,

The 2nd international science symposium "BalticSTE2017" materials are in your hands. This book presents some important issues related to the science and technology education today and in the future. It highlights different aspects of this important area. Though the name of the symposium itself emphasizes the Baltic region, however the symposium's report panorama is very wide. The works of scientists from Brazil, Czech Republic, Slovenia, Poland, South Korea, Turkey, Italy, Finland, Croatia, Bosnia and Herzegovina, Russia, USA, Slovakia, Portugal are published here. The newest natural science and technological education area research are presented in them, global perspectives are shown, insights are drawn.

Natural science and technological education area is wide and rapidly changing. The technologies are constantly changing and improving, the newest natural science discoveries/achievements surprise us every day. Young generation must acquire qualitative this area education. On the other hand, rapid natural science and technology development makes us seriously consider achievements in ethic, social and other aspects. Speaking about scientific research in education area, it is important to highlight scientist and researchers' responsibility. Not without reason, it is being discussed at the international level about responsible educational research (RER), where the most important things become transparency and responsibility of educational research. Moreover, the ethics issues are crucial in all types of science and technology education research.

Natural science and technology education (STE) research have to be grounded in systematic and integrative approaches and on the main science, technology and society interaction theory. As the most relevant STE fields, one has to mention natural science and technological education links, integrated and interdisciplinary education approaches, natural science teacher and mathematics teacher collaboration ways and possibilities making STE process and etc. more effective. Natural science and technological education condition research (STE monitoring) in all general education and higher school stages are important and should be developed. Natural science knowledge (nature cognition) mastering motivation and practical nature research / environmental activity research are not less important. Nature subject and technology subject teacher preparation quality diagnostic research also cannot be left aside.

Thus, it is obvious that not only current or newly written textbooks, computers and other modern technologies, renewed material basis of schools will determine success and effectiveness of natural science and technology education, but first of all education manager and organiser attitude and understanding. Equally the same understanding

should also get stronger in the minds of natural science teachers, and scientists' mission is to build those necessary "bridges" between theory and practice. From the point of view of education practice, the most actual spheres are general and subject competence education, interdisciplinary relations (latterly, passing to STEAM education), research grounded education and other.

It is important to constantly discuss about what inspires to do scientific research, what encourages researchers to participate in scientific activity. What happens, that some works remain deep down in the drawers and are forgotten, and the others spread widely and are practically applied? How do natural science and technological education researchers themselves treat their work and understand its importance?

In 2015 the first international symposium BalticSTE2015 took place. In the symposium book 34 articles were published. This is an open access publication, which can be found at: https://www.academia.edu/13101334/state-of-the-art_and_future_perspectives. Also, one can find a short video about the first symposium at https://www.youtube.com/watch?v=1q2vUdS_oN0. The symposium gave quite a big impetus to all working in STE field. One can hope, that the reports made during the second symposium, the presented research will give an even bigger impulse to natural science and technological education development and improvement.

First of all, I want to express my sincere gratitude to all invited speakers Prof. Dr. Jonas Jasaitis (Lithuania), Prof. Dr. Raffaele Pisano (Italy), Prof. Dr. Agnaldo Arroio (Brazil), Prof. Dr. Andris Broks (Latvia), Prof. Dr. Miia Rannikmae (Estonia), Dr. Angela James (South Africa) for their determination and willingness to participate in the symposium work and their expressed thoughts. Also, I want to thank all scientific committee members for their great contribution preparing symposium scientific programme and organizational committee members for their contribution organising this important scientific event.

RESEARCH BASED LEARNING AND PROPRIOCEPTION

Boris Aberšek, Kosta Dolenc
University of Maribor, Slovenia
E-mail: boris.abersek@um.si, kosta.dolenc@um.si

Andrej Flogie
Institute Anton Martin Slomšek, Slovenia
E-mail: andrej.flogie@slomskov-zavod.si

Abstract

Much of the discussion is currently connected with our thought, our judgements, with our brain, especially connected with the learning process and methodology how to effectively learn. Most of our judgments and actions are appropriate most of the time. As we navigate our lives, we normally allow ourselves to be guided by impressions and feelings, and the confidence we have in our intuitive beliefs and preferences is usually justified. But not always. We are often confident, even when we are wrong, and an objective observer is more likely to detect our errors than we are. But a problem arises if we neglect comments or proposals of this observer. In this case you must take into account proprioception. It could also say "self-perception of thought", "self-awareness of thought" or "thought is aware of itself in action". Whatever terms could be used, thought should be able to perceive its own movement, be aware of its own movement and if so, at the process of problem solving (problem and research based learning) we are developing the system of thinking in an intuitive, heuristic and slow, systematical thinking.
Keywords: *cognitive education, research based learning, proprioception*.

Introduction

To be a good teacher, you need to acquire a large set of different kind of interdisciplinary knowledges, each of which binds an idea of the causal relation, cause and consequences, possible antecedents and causes, possible developments and consequences, and possible interventions to strategy of teaching. Education for teacher and trainer consists in part of learning the language of education and appropriate skills. A deeper understanding of judgments and choices also requires a richer vocabulary than is available in everyday language. Learning is closely connected with the body-mind relation, connected with our way of thinking. When you are asked what you are thinking about, the answer is not very complicated. You believe you know what goes on in your mind, which often consists of one conscious thought leading in an orderly way to another. But that is not the only way the mind works, nor indeed is that the typical way. Most impressions and thoughts arise in your conscious experience without your knowing how they got there. You cannot imagine how you came to the belief that everyone loves you, or how you detected a hint of irritation in your spouse's voice on the telephone or how you managed to avoid a threat on the road before you became consciously aware of it. The mental work that produces impressions, intuitions, and many decisions goes on in

silence in our mind. It's like the thought have their own thought and language, the language of thought (Fodor, 2008).

The use of contemporary learning strategies as research and problem based learning connected with brain based technique and information communication technologies provided scholars from diverse disciplines-notable philosophers, linguist and engineers-an unusual opportunity to observe possible flaws in their own thinking. Having seen themselves fail, they became more likely to question the dogmatic assumption, prevalent at the time, that the human mind is rational and logical (Aberšek, Borstner, Bregant, 2014). The choice of method was crucial: if we had reported results of only conventional standard methods, our work would have been less noteworthy and less memorable, so we did not choose demonstrations over standard methods because we wanted to influence all spectre of audience. We preferred demonstration, problem and research based methods because they were more fun, and we were lucky in our choice of method as well as in many other ways. A recurrent theme of this research is that proprioception plays a large role in every story of success learning; it is almost always easy to identify a small change in the story that would have turned a remarkable achievement into a mediocre outcome. The results of our research were no exception (Flogie, Aberšek, 2015).

Problem and Research Based Learning

When the problem is difficult and a skilled intuitive solution is not available, intuition still has a shot: a solution may come to mind quickly–but it is not a solution to the original problem. The problem that the executive faced was difficult, but the respond to an easier and related problem came readily to his/her mind and determined choice. This is the essence of intuitive heuristics: when faced with a difficult problem, we often answer an easier one instead, usually without noticing the substitution. So, it is very important that in the research-teaching/learning process the appropriate problem will be used.

The spontaneous search for an intuitive solution for our problem sometimes fails–neither an expert solution nor a heuristic answer comes to mind. In such cases, students often find ourselves switching to a slower, more deliberate and effortful form of thinking. So, in the process of problem solving, developing the system of thinking in an intuitive, heuristic and slow, systematical thinking has been developed. The responsibility of the teacher is, to equally develop all ways of problem solving with preparing appropriate research problems.

Systems of Thinking at Researching and Problem Solving

Thought is a part of material process. It goes on in the brain, the nervous system, the whole body – it is all one system. Within the body, thought is conveyed by nervous system signals; there is a code of some sort which we don't know too well. Thought is so material process which has reflexes that just go on by themselves. If you have an insight or perception that this is true, then this will actually affect you. That's the notation: the insight or perception will affect the whole thing. It not only affects the inferential understanding, but it also affects the chemical level, the tacit level (language of thought, Fodor, 2008) – everything. If we suppose that thought is a material process and thought

participates, which means the notion that thought is only telling you what things are, it is not in reality a serious option. If that comes as an insight, or if you get the insight that thought is not proprioceptive but requires proprioception, then that could begin to touch the synapses in the brain which hold those reflexes. What is meant with proprioception. Proprioception means self-perception of thought, self awareness of thought, so someone who is thinking should be able to perceive its own movement, be aware of its own movement. Be aware of his/her own thought. And that's the way to higher taxonomic level of knowledge. Inside research based learning we are automatically developing such critical thinking process (Bohm, 2004, Kahneman, 2011).

Research Combined with Brain Based Learning

There are a huge number of opportunities to introduce novelty as proposed research learning in learning process simply by being creative; for instance, the teacher can use fresh examples or problems, surprise students with new data or present a scenario that’s completely unpredictable. Or, engage students through games and simulations that require students to apply the information in unfamiliar contexts. In eLearning environments, role play, energizing online discussions and quick serious games can all add sensory stimuli to raise blood pressure and epinephrine levels to eliminate drowsiness, reduce restlessness, and reinforce information. Allowing learners to do some research and exercises on their own to better understand abstract ideas, write an essay or work with an interactive simulation are also helpful strategies (OECD, 2007, Howard-Jones, Pickering, Diack, 2007).

Research Methodology and Results

The proposed research based method has been evaluated in experimental group in two schools with 69 students from city school and 58 students from suburban school. Quantitative data in the experiment were collected, reviewed and rated by a group of experts in the field of technology and science. The acquired results were analysed via descriptive statistical techniques. The control group is the whole population (national evaluation), achieved an average of 4,34 points in the summative assessment. The experimental group, composed of 127 students, achieved an average of 5,31 points in the summative assessment. The standard deviation in both groups is very high, which confirms that there are great differences in the students' levels of knowledge. From the results it is obvious, that proposed research and problem based strategy of learning are very effective methods.

Conclusions

There is a simple way to design effective learning with the use of advanced learning environment about any subject by using research based learning combination with brain-based technique. The idea behind the concept is that learning is innate and linked to biological and chemical processes in the human brain. Much of the time, teachers are unaware that they are hindering the learning process through ineffective teaching methods and inappropriate design. When teachers have a greater knowledge of neuro-

science and of the brain, they are able to make better decisions about design and create richer learning conditions that attend to students' social and emotional needs. With such knowledge they can in the process of research and problem solving, develop the system of thinking in an intuitive, heuristic and slow, systematical thinking.

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PRESCHOOL CHILDREN'S IDEAS ABOUT LIVING THINGS

Şule Bayraktar
Giresun University, Turkey
E-mail: sulebayraktar@yahoo.com

Zeynep Kuvvet
Recep Tayyip Erdoğan University, Turkey
E-mail: zeynep.kuvvet@erdogan.edu.tr

Abstract

The purpose of this research is to examine pre-school children's ideas about living and non-living things. Children were asked to determine whether particular objects in the pictures shown to them are living or non-living and asked to explain why they think so. The results of the research showed that majority of children can classify living and non-living things correctly and know that motion is a characteristic of a living thing. However, they held some alternative conceptions on the subject.
Keywords: *living things, alternative conceptions, pre-school children, science education*.

Introduction

One of the fundamental aims of education is to help individuals to construct particular concepts correctly. However, students might already have constructed ideas about many natural phenomena by means of their observations, experiences and interactions with the environment before they begin formal education in schools. It is important for educators to be aware of these preconceptions in planning their instruction. Life concept is one of these concepts that constitutes a basis for biology, thus has an important place in primary school curriculum.

Piaget identified five stages in the development of the life concept in children. According to him children younger than 6 years old have no concept of life. Children at age 6-7 think that things that are active in any way, including falling or making a noise, are alive. Children at age 8-9 think that all things that move and only those, are alive. Children 9-11 years think that things that appear to move by themselves, including rivers and the sun are alive. Over 11 adult concept only animals are alive or animals or plants alive.

Studies examining the children's conceptions on living and non-living things date back to 1970's. For example, Looft (1974) examined the children's life concept by asking them to determine whether particular objects are living or non-living. Although 39 out of 59 students correctly classified objects, this result was not indicative of biological grasp of implications of the life concept. Over half of the 39 understood the need for nutriment but few applied a concept of breathing or of reproduction in defining living things even when asked questions as "do frogs breathe or need air?"

Tamir et al.(1981) found that most popular criteria as indicators of life for all age groups were movement for animals, and growth and development for plants and

embryos. Results of the Bell (1981) study showed that the most popular attribute chosen to identify living things were eating/drinking, moving/ walking, breathing and growing. There was little progression evident in the responses from primary to junior secondary students although older students gave the best results.

Piaget's stages for development of life concept seem controversial in the present day. Because, many children, even as young as 6 year-old appear to classify the objects correctly and grasp that everything that move is not a living thing. Many children also do not have an idea that only moving things are living things. Purpose of the present study is to examine pre-school children's ideas about living and non-living things.

Methodology of Research

This research is conducted with 44 children who are attending a Kindergarten in a town at Black Sea Region in Turkey. Students aged 5-6 years old, 24 girls and 20 boys. Students were shown pictures of particular objects and asked to indicate whether they are living or non-living things. Students were also asked to explain why they think it is a living or non-living thing. Students' answers were recorded by the researchers. Students' answers for each object regarding living or non-living status were analysed by descriptive analysis and the results were presented as percentages and frequencies.

Furthermore, students' explanations about the reason why they think the objects were living or non-living were examined to find out how they construct these concepts in their minds, what properties they attributed to living and non-living things and whether they have alternative conceptions.

Results of Research

Results of the research showed that majority of the students classify living and non-living objects correctly. Most of the children know that animals are living things, however, almost half of them think that plants are non-living. Students' answers reveal that they associate life with motion. It is possible that for this reason they classify plants as non-living things. These children, as a result of this idea, put some non-living objects such as cars in living objects category. The most mentioned second property by children is nutrition, and other characteristics of living things are mentioned by very few students. Furthermore, some children think that a living thing must have organs such as eye, mouth, hands or feet.

Conclusions & Implications

Results of this research show some differences from that of Piaget's work on the subject. As indicated earlier, Piaget claims that children younger than 6 years old do not have life concept. However, this study showed that many children at this age have correct ideas about life and living things. This finding might be a result of the information age that children born in a world that all kind of information is easily reachable by them, after some 60 years after Piaget's work was introduced, consequently construct their concepts much earlier than their counterparts in those years.

This research was conducted with pre-school children attending kindergarten. Research studies carried out with children who are not receiving preschool education might produce different results. Future studies comparing the ideas of children who are attending and not attending kindergarten can give a clear idea about whether the difference is as a result of pre-school education.

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HOW MUCH DO NURSES REMEMBER FROM SCHOOL PHYSICS? SOME RESULTS OF COMPARING ANALYSIS

Zuzana Balázsiová
Comenius University, Slovak Republic
E-mail: zuzana.balazsiova@fmed.uniba.sk

Abstract

The aim of this research is to determine the level of elementary physical knowledge, which can be used for solving the problem of nursing task. For this purpose original didactic test was used, which contained tasks from elementary physics and tasks of nursing, too. It was found, that nurses minimally remembered physical knowledge. Nurses preferred to solve practical nursing tasks only by using nursing knowledge. Decoupling physical and nursing knowledge may cause the increased risk of damage to health nurses and patients.
Keywords: *knowledge retention, solving of practical nursing tasks, physical knowledge in nursing.*

Introduction

It is very little known, that health care practice of doctors, nurses and other health-care professionals is linked with the knowledge of physics. (Mackova et al, 2014, p.65) We assume that the quality they work is also directly related to the level of knowledge of physics. Nevertheless, among students of medicine or nursing (as well as other health study programs) an idea is often formed that (bio) physics is a difficult and useless teaching subject. Many students do not appreciate its importance and the reasons for its implementation into the curriculum. (Balazsiova, 2012, p.43) The cause of this situation is in teaching process at the secondary school. Relations between physics and biology are a little known among secondary school teachers.

The aim of our research was to find: 1. level of physical knowledge, which nurses are able to use for solving tasks of nursing, 2. whether nurses are able during solving the tasks of nursing to recall basic physical concepts that have been learned in high school.

Methodology of Research

The group of respondents included 266 nurses – students of the 1st and 2nd year of Master part-time study of nursing. The mean age was (33.62 ± 8.68) years. The youngest respondent was 23 years old and the oldest one was 57 years old. Their duration of nursing practice ranged from 0 to 38 years. 176 respondents were graduates of secondary medical schools. 19 respondents graduated from high school, 8 respondents had completed secondary education other than Secondary Medical School and high school.

Original written test was used. 11 questions were based on nursing practice and 9 tasks were based on elementary physical knowledge. There were couple of questions (nursing and physical), which were possible to solve by analogical physical principle. Nursing tasks could be solved just by nursing knowledge, too. This test has been validated by High school curriculum and curricula of Slovak Medical Faculties. Statistical analysis was used for evaluation of test results.

We set the threshold of success on 60% of correct answers, according to the didactic rules of test evaluation.

It was studied:

- what was the average success of respondents. Average of correct answers of nursing and physical components of the test ± standard deviation was calculated.
- whether there was a statistically significant difference of individual knowledge among respondents. We considered the critical value for variation coefficient $V_c = 0.30$
- whether there was any correlation between the results of corresponding answers in both components of test (nursing and physical). The critical value for correlation coefficient was r = 0.1946

Results of Research

Solving tasks regarding nursing (11 questions)

Respondents answered correctly (6.71± 1.59) tasks i.e. (61.00±14.45) %, solution, which could depend also on their (bio)physical knowledge. The best achieved result was 11 (100%) and the worst 0%. The median of achieved points was equal 7. The mode equals 6 points. It means 6 correct answers of 11 questions.

The variation coefficient indicates, that individual differences in the knowledge level among respondents were not statistically significant ($V_c = 0.237$).

Solving tasks with physical topic (9 questions)

Respondents answered correctly (4.21 ± 1.76) tasks i.e. (46.77± 19.55) %. The lowest obtained result was 0 points. Two respondents gained maximal number of points. Majority of the respondents received 3 points (Mode = 3, Median = 4).

Unlike previous part focused on applications of (bio)physics in nursing practice, variation coefficient showed statistically significant difference in physical knowledge level among respondents (V_c=0.419).

Correlation between selected pairs of questions

1A. What is the volume of liquid in the graduated cylinder? (There is a picture in the test)
a) 0.125 dm^3
b) 0.0125 dm^3
c) 0.0120 dm^3

1B. 1 litre equal:
a) 1000 dm^3
b) 10 dm^3
c) 1 dm^3

The question was focused on physical unit conversion and skills to read a calibrated graduation. It is important for preparation and administration of drugs in liquid form (infusion, injection) in practice nurse. Correlation between both questions was statistically significant ($r = 0.2163$, $p<0.05$).

2A. Centre of gravity human body is localised:
a) Outside the body
b) In the chest
c) In the pelvis and abdomen

2B.The centre of gravity ring is located:
a) In the space on the inside of the ring
b) Inside the ring (in the body)
c) In the space on the outside of the ring

Knowledge about centre of gravity is important for handling and positioning of the patient. Poor knowledge may cause to musculoskeletal disorders nurses and health risk of patients. Correlation between both questions was not statistically significant ($r = 0.0234$, $p>0.05$).

Conclusion and Implications

It was found that practice nurses have a poor biophysical knowledge. It is assumed, that negative attitude of students to biophysics, poor fundamentals of physics from high school have effect on the results of our research (Kukurová et al., 2007, p.2). If students lack the fundamentals of school physics, it is unlikely that their new knowledge, skills and abilities acquired at university will be of a permanent nature. In this case, forgetting and distortion of information is very fast. Our results confirmed that forgetting is so intense that elementary physical knowledge cannot be recalled even after solving similar problems of nursing. In most of the cases statistically significant feedback between solution of nursing problems and elementary physical problems was not found (coefficient of correlation was less than critical value).

Generalising the results of our research, one can assert: “In case of insufficient physical knowledge of health professionals, the risk of error in their work is increasing”

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COLLABORATION BETWEEN PHYSICS AND CHEMISTRY TEACHERS AND EXPERT: A CONTRIBUTION TO TEACHERS' PROFESSIONAL DEVELOPMENT

Mónica Baptista
University of Lisbon, Portugal
E-mail: mbaptista@ie.ulisboa.pt

Abstract

The aim of the research was to know the contribution of collaborative work between teachers and an expert for their professional development. The collaboration was promoted during a training program involving five steps: Plan, Action, Collect, Interpret and Reflect. This study involved six physics and chemistry teachers. Results show that the teachers felt that the collaborative work promoted learning related to the applicability of the theory to practice, with the formulation of inquiry tasks and their implementation in the classroom.
Keywords: *professional development, teachers' collaboration, training program*.

Introduction

Several studies have been conducted on issues related to teachers' professional development (eg. Butler, Lauscher, Jarvis-Selinger & Beckingham, 2004). The concept of professional development resulted from recognition of lifelong learning as a necessity. The word development requires a change and continuity that leads teachers to deepen their knowledge throughout their career (García, 1999). The holistic nature and dynamics of professional development, which includes the experiences of formal and informal learning, is mentioned by Day (2001). In this context, it is important to know that professional development requires a holistic perspective of the teacher - the teacher in school's context, the teacher as a means of curriculum development, the teacher in teaching / learning process and the teacher as a person. Thus, the development of the teachers maintains their learning throughout their career and providing resources for a personal investment (Day, 2001). In a society that is constantly changing, it is important that teachers see themselves as learners.

The collaboration between teachers and experts is one key to professional development. The collaborative work is supported by the interaction, dialogue, and critical reflection. In fact, an effective collaboration requires communication, decision making and problem solving (Loucks-Horsley, Hewson, Love & Stiles, 1998). The collaborative work between experts and teachers is important to both, building bridges between educational research and practice.

The aim of the research was to know the contribution of collaborative work

between teachers and an expert for their professional development. The collaboration was promoted during a training program involving five steps: Plan, Action, Collect, Interpret and Reflect. In the planning step, teachers together with the expert have developed a set of inquiry tasks that were put into action in their classrooms. During this step, data were collected on the difficulties of the students and the strategies they used to perform the tasks. Finally, teachers and expert, together, have interpreted the gathered data and the teachers had the opportunity to reflect on their practice, using the evidence gathered from the classroom and linking theory with action.

Methodology of Research

In this research, a qualitative and interpretive methodology was used (Erickson, 1986). According to Erickson, in its broadest sense, interpretive research concerns the "immediate and local meanings of actions, as defined from the actors' point of view", (p.119).The participants of this study were six Physics and Chemistry teachers from schools within the region of Lisbon. They were all females and their ages range from 25 to 47 years old. Two of them are Master' students in Science Education, one has a Master in Science Education, and another has a Master in Physics for Teaching. Data sources for this study included audio recording of interactions between expert and teachers, interviews at the end of each step, written reports and reflections by teachers. Different tools to gather data for triangulation and trustworthiness in the findings were used (Lincoln & Guba, 2002). All the tape recorded material is transcribed by the researcher.

According to an interpretative approach (Erickson, 1986), we used a method of content analysis (Strauss & Corbin, 1990) for studying type and quality of answers and arguments presented. It was an iterative process of reading and re-reading data so to uncover patterns, singularities and themes which were associated to the research question. From this process many structures and interrelationships have emerged that were rebuilt in a coherent whole and contextualized taking into consideration teachers' original context (Denzin, 2002).

Results of Research

The results show that the teachers felt that the collaborative work promoted learning related to the applicability of the theory to practice, with the formulation of inquiry tasks and their implementation in the classroom. In fact, it allowed the teachers to connect new ideas to that already held; change these ideas and create new; change some of their concepts about teaching and learning; and develop strategies to promote the students' learning.

During the training program, the interaction between expert and teachers led them to change how they interpreted curriculum. Teachers changed their beliefs about the nature of good teaching and learning, and made new adaptations of curricula to develop classroom activities. The following extract from the audiotapes is an example:

> "It isn't easy to adapt and to apply the curriculum. When we started this activity, I read the curricular orientations and I thought that the most important were the concepts and facts. Then, I made another reading with you and our discussion allowed the reflection. Now, I can say that I changed my point of view. I think that I understand the intention of

the curriculum developers. So, for example, one can begin the activity with a question that engages pupils to empirical investigation".

This teacher understood the importance of using curriculum as a resource for their own design of activities.

Conclusions

The different steps of training course were developed to the rhythm of each teacher and in their natural context. During the training course was present the dialogue, mutual respect, trust, negotiation, ideas' confrontation and arriving at a consensus. The atmosphere of trust set up during the various stages of the training program led teachers to new learning and allowed them to explain their fears and change their practices. These knowledge and changes have contributed to their professional development.

The proximity of the expert promoted access to the reality of each teacher and allowed a blurring of the gap between theory and practice. Therefore, it is recommended that in future research focused on collaborative work, this aspect be taken into consideration.

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IDENTIFICATION OF KEY AND CRITICAL POINTS IN EARLY CHEMISTRY CURRICULUM IN CZECH REPUBLIC

Martin Bílek
University of Hradec Kralove, Czech Republic
E-mail: Martin.Bilek@uhk.cz

Jiri Rychtera, Katerina Chroustová
West Bohemian University, Czech Republic
E-mail: jaretchyr@gmail.com, chroustk@cbg.zcu.cz

Abstract

In the contribution possibilities and limits of the early chemistry curriculum innovation in the Czech Republic at time of current curricular reform are discussed. An example of chemistry subject matter in educational content and the context are focused. Methodology of research is based on interview with chemistry teachers, and partial results present problems with cognition overload of the pupils and the necessity to improve the content, particularly to build stronger connection to everyday life and forming of science literacy.
Keywords: *early chemistry education, key and critical points of curriculum, chemistry teachers*.

Introduction

In the time of curricular reform in the Czech Republic another chance appeared towards increasing learners´ interest in science instruction, particularly in relation to the future job selection in the field of natural science and technology. Innovations in natural science instruction can be conducted in various ways, e.g.:

- Learners´ interest in natural science and the instruction (What am I interested in?; What would I like to learn? What learning content should be learned?) – answers to these were discussed i.e. in the analysis of the international comparative study ROSE (Relevance of Science Education);
- Context of instruction (optimally – "school science", application context, social context, personality context);
- Learning content (standards; Framework and school programmes; traditions; new topics);
- Competences (key competences; "scientific literacy"; activities in natural science).

The current constructivist approach to instruction in schools is characterized by the dominant position of the teacher and receptive passivity of learners. Scientific knowledge is built in such a form which nearly excludes its application and exploitation in the future. Learners are not able to use the knowledge in real situations because they do not discover its relation to the reality; they are able to apply the abstract knowledge in the

real situation. The teacher should create content-rich communicative environment which will address the subjective knowledge area and at the same time which contains new puzzles inviting to creative self-orientation. The teacher art lies in the ability to forecast the chain of consequences between original construction of the reality with the learner and scientific knowledge which the learner understands as the state of expected conflict, solves it via the trial-error way. The attention is paid to the individual with subjective content of knowledge and experience (Bilek & Kleckova, 2006). Recently, the Chemistry Didactics department, Faculty of Science, University of Hradec Kralove, co-operated in several projects aimed at innovations in the current general science, particularly chemistry education. First of all, on the national level, the project from the operational programme Research, Development and Education (OP VVV) "Didactics: Man and the Nature A", should be mentioned, which is conducted in co-operation with University of West Bohemia, Plzen, Jan Evangelista Purkyne University, Usti nad labem, and Palacky University, Olomouc, focuses on identification of key and critical points of science curriculum on the lower secondary school.

Early Chemistry Curriculum in the Czech Republic

The research project focuses on the identification of key and problematic (critical) parts of science instruction on the lower secondary school level through building the practical environment of teachers and teachers´ educators. Within the project teachers participate in following activities:

- Identifying key and problematic (critical) points in the curriculum and classifying them from the view of importance within the subject paradigm (setting the key points and relation to key concepts), demandingness for learners, teacher´s self-assessment and the current development of the subject (dynamic point of the curriculum),
- Defining the methodological processes and strategies to teaching/learning problematic (critical) points of the curriculum, including their optimization and verification in the action research.

Methodology of Research

The main research method is semi-structured interviews with teachers and comparison of collected data to the analysis of the subject curriculum in relevant educational national and international documents. Single items of the semi-structured interview focus on identification of concrete conditions of teacher work, their opinions on learning content and context of instruction, and other relating aspects, e.g. textbooks used, laboratory equipment, co-operation with companies and non-educational institutions etc. The research sample consisted of 123 teachers from 74 lower secondary schools and teacher educators from four partner universities and two Science Centres; the research sample dealing with early chemistry education includes 32 teachers and 9 teacher educators.

Results of Research

Currently, the research project has been in the phase of piloting the research tool, i.e. the semi-structured interview. The first results tend to verify the expected critical

fields of the early chemistry curriculum, i.e. mainly chemical calculations, field of electro-chemistry, chemical nomenclature and professional communication. The results also show more attention should be paid to following areas, in which chemistry teachers can contribute substantially towards reaching to projects objectives, particularly following items areas of the semi-structured interview:

1. Do you think that the process of instruction following the school educational programme, created by the school and reflecting main ideas and intentions of curricular documents, is in the whole more effective compared to the previous approach exploiting strictly defined items in curricula?
2. What learning content do you consider to be the key one that effective chemistry instruction cannot be conducted without?
3. What learning content do you consider critical in the early chemistry instruction, i.e. the content learners often fail, resp. do not acquire it? Do you consider any learning content of this type useless in your school educational programme?
4. Would you mention any topic which in your opinion would attract learners´ interest and still is not included in the instruction from the reason of limited content?
5. Do you agree with the learning content of the early chemistry instruction without the traditional field structure, or would you prefer having the thematic plan (set of topics) based on the motivational potential of the topics taught?

Conclusions

The above presented research project, having the ambition to substantially contribute to the innovation in teaching the science subjects, including chemistry, at the basic (primary and lower secondary) school in the Czech republic, has been conducted for six months. The main emphasis has been paid on the setting of the research design and creating the relevant research tool. The first results show this approach to be correct, both in problem identification and building so called "teacher practice community", the narrow co-operation of in-service teachers and subject didacticians – teacher educators.

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A REFLECTION OF PRESERVICE SCIENCE TEACHERS' VIEWS OF OPEN ACCESS DIMENSION OF RESPONSIBLE RESEARCH AND INNOVATION

Cagla Bulut, Bulent Cavas
Dokuz Eylul University, Turkey

Kadir Demir
Georgia State University, USA

Abstract

European Union has recently begun placing emphasis on sharing of scientific process as well as knowledge with public as part of Responsible Research and Innovation (RRI) approach. During RRI process, research results are required to be accessible to public for efficient scientific communication. It is hereby significant to evaluate pre-service science teachers' views. Thus, this study focused on pre-service science teachers' views of RRI using RRI-questionnaire. Preliminary results show that pre-service science teachers have positive views towards RRI-open science dimension.
Keywords: *open science, Responsible Research and Innovation (RRI), pre-service science teachers*.

Introduction

As it can be clearly seen that science and technology have been developing by new discoveries and methods, thus scientists and funding organizations are inevitably supposed to be in cooperation to keep pace with new ages. Thus, as a significant funding agency, European Commission has decided to support more projects and policies whose purpose is to adapt to rapidly developing scientific and technological improvements. In this case, another point has been considered to integrate society into these changes by raising their scientific awareness and scientific literacy. As an emerging and broad concept, Responsible Research and Innovation (RRI) focuses on the necessity that all societal actors should synchronize with each other in order to meet European citizens' expectations and values. Additionally, RRI is required to be transparent in a way that openly makes available the scientific and technological study results to public for efficient scientific communication (Grigorov & Tuddenham, 2015). This is also pointed out as an essential subject that European Commission focuses on the field of science and technology. Especially, publications and data of public based projects should be accessible to all public (European Commission, 2014). Moreover, reuse, identification, and production of knowledge can be provided through the cooperation of researchers by making scientific data transparent (Schmidt, Orth, Franck, Kuchma, Knoth, & Carvalho, 2016).

Methodology of Research

To collect data from pre-service teachers, a RRI-questionnaire was developed in the lights of related explanations and definitions of European Commission documents and examining the literature regarding RRI and its dimensions. The sample included 270 preservice science teachers enrolled in 4th grade science courses in colleges of educations housed at five different universities located in Aegean Region of Turkey. It was aimed to study the views of pre-service science teachers' on the basis of 5 themes (public engagement, ethics, gender equality, science education and open access). These five themes were used as a framework for constructing the RRI questionnaire. Once the research data were collected from research participants, we analyzed the data for frequency and percentage values for each item besides mean scores of themes were calculated as well. Item analysis of RRI questionnaire was made by estimating frequency and percentage values in order to evaluate preservice science teachers' views towards RRI. A five-point scale ranging from 1 to 5 as follows: 1-Strongly disagree, 2-Disagree, 3-No opinion, 4-Agree, 5-Strongly agree was developed for pre-service teachers to rate the extent to which they gave emphasis to each RRI questionnaire. In the questionnaire, there exists a part consisting gender, parent educational background and growing-up information in order to examine the data in terms of demographic features. At the first, 31 items were formed by scanning the related literature and in the light of explanations and definitions of European Commission (EU, 2014). The questionnaire was reorganized after expert opinions were evaluated in order to determine the efficiency of items regarding context validity. Based upon the opinions of 5 teaching & research staff from departments of science education and Computer Education and Instructional, items were revised and 7 items were excluded from the questionnaire. In the final step, the questionnaire was expertized for the accuracy of orthographic and spelling rules by consulting to a professor in Turkish language and literature education. The final version of questionnaire consists of 24 items. As for internal consistency reliability, cronbach alpha value was found 0.962 showing that reliability is excellent ($\alpha \geq 0.9$). In order to implement questionnaire, official permissions were taken from related universities and then administered to sample defined in the study.

Results of Research

Table 1 shows the scores of 6 items forming open access theme. According to the table, item 9=4.1556, item 8=4.1037, item 11=4.0259, item 10=3.9741, item 13=3.7778, item 12=3.6259. Mean score of open science theme items is 3.9439.

Table 1. Open access theme item scores.

Theme	Item	Score
OPEN ACCESS (6 ITEM) Mean: 3.9439	Free access to scientific research findings is needed for society.	4.1556
	Dissemination of knowledge is one of the most important strategies of open access.	4.1037
	Open access to scientific research findings provides scientific improvement.	4.0259
	Free access to scientific research findings for society contributes to science and innovation process in private and governmental institutions.	3.9741
	Emerging approaches like data mining are of great importance in dissemination and impact assessment of research findings.	3.7778
	Dissemination of research findings is more important than research process.	3.6259

When the items in the table ranked most by pre-service science teachers in the context of open access theme are examined, it is shown that they have positive views in subjects mentioning that scientific research findings necessary for society should be accessible, the most significant action of open access is the dissemination of knowledge, scientific findings are required to be accessible to all societal actors for scientific improvements, free access to scientific research findings can contribute to science and innovation process. Nevertheless, it is found out that pre-service science teachers relatively have less positive ideas in subjects declaring that emerging approaches such as data mining are significant in the dissemination of knowledge and research findings are more important than the research process.

Conclusions

In the context of this study, a questionnaire was developed considering RRI explanations and its themes in order to evaluate pre-service science teachers' views of RRI. This paper focused on open access dimension which is considered a significant element of science and innovation process. Item scores and the mean value were calculated by the purpose of analyzing the direction of participants' views. Based on scores, it was found out that the mean value of open access theme is 3.9 which means that agree option was ranked most. This shows that pre-service science teachers who attended this study from Aegean region of Turkey can be regarded as adaptive to RRI approach and open access dimension.

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STUDENTS' PERCEPTIONS TOWARD SCIENCE COURSE AND INQUIRY BASED SCIENCE EDUCATION (IBSE) IMPLEMENTATION IN SCHOOLS STUDY EARTHQUAKES (SSE) PROJECT

Bulent Cavas, Cagla Bulut
Dokuz Eylul University, Turkey
E-mail: bulentcavas@gmail.com, caglabulut@hotmail.com

Abstract

The main aim of research is to investigate students' perceptions toward science course before and after the Inquiry Based Science Education (IBSE) implementation during science lessons. The research also examines teachers' use of inquiry based science education in their classrooms. The topic of earthquake was selected as the main focus to implement IBSE and related activities in this field. The research is a part of "Schools Study Earthquakes (SSE)" project, which is funded and supported by European Union Erasmus Plus program. The results show that IBSE supported instruction positively affected students' perception toward science course. In addition, the educational approach of the project, IBSE, seems to be an effective method to teach earthquake phenomenon and earthquake-related subjects to students by science teachers.
Keywords: *earthquakes, inquiry based science education, science teachers, students' perceptions.*

Introduction

Schools Study Earthquakes (SSE) is an Erasmus Plus project, supported by European Union Erasmus Plus program and coordinated by National Observatory of Athens (NOA). The project focuses on the study in the reality of classroom practice of a physical phenomenon (earthquake) with great societal impact and proposes pedagogical practices based on inquiry based science education methods that are more effective in science education (Rocard, 2007).

The project also proposes the use of educational seismometers to collect real data, do real analysis of real situations and real earthquake phenomena in real time. The project includes teacher trainings on the use of educational seismometers and how to implement inquiry based science education in their teaching and learning environments.

The main aim of this research is to obtain real proof about (a) the changes of students' perceptions toward science course and (b) the changes of teaching approaches implemented in a classroom environment.

Methodology of Research

In this research two instruments were used to collect data from students and teachers in order to find out educational changes. The first instrument developed by Relevance of Science Education Project (Sjoberg, Schreiner, 2010) was used to collect data from students measuring their perception toward science courses, such as their motivation in the field of science at school, their self confidence in their own abilities in science at school, what they gain from science at school, their perception for the necessity of science education etc. It is a well known issue that aspects like self confidence, attitude, interest and motivation are key factors associated with teaching and learning of science in formal and informal education. The second instrument was designed to collect data from teachers. It is clear that there is a need to clarify teachers' preferences related to their use of inquiry-based science education in the classroom. For a science teacher to enact teaching science as inquiry, the teacher is required to develop approaches that situate learning in authentic problems, model actions of scientists in guiding and facilitating students to make sense of data, and support students in developing their personal understandings of science concepts (Crawford, 2007). The questionnaire used as an instrument in this research consists of two parts. The first part consists of 4 questions, focuses on the demographic information of science teachers, including gender, grade level, teaching subject and length of science teaching experience. The second part of the questionnaire includes 27 items. The participants were asked to respond using a five-point scale (from almost never to almost always). The score 1 represented the option "almost never" while score 5 on the scale represented the category "almost always". All of the items were positively written (Cavas, Holbrook, Kask, Rannikmae, 2013). In the research, data were collected from 300 students and 20 teachers from 10 state and private schools located in Izmir-Turkey.

Results of Research

The SSE project and its implementations have been the first innovative and educational approach in Turkish schools by collecting real-time data for real earthquakes. According to the results obtained from the data, students' perception about their teaching and learning environment positively changed after SSE project implementations. In addition to these positive changes in students' perception, the teachers' use of inquiry based science education in classrooms dramatically increased after teachers' professional development courses.

Conclusions

As a general remark, the educational approach of SSE project has been a nice model for teaching the subjects regarding earthquake to middle school level students. The approach can be used and implemented to motivate and encourage teachers about using IBSE as an effective teaching method in their classrooms.

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LESSON STUDY AS A PROFESSIONAL DEVELOPMENT PROCESS OF PRE-SERVICE PHYSICS AND CHEMISTRY TEACHERS

Teresa Conceição, Mónica Baptista, João Pedro da Ponte
University of Lisbon, Portugal
E-mail: teresamaldonadosousa@yahoo.com, mbaptista@ie.ulisboa.pt

Abstract

The aim of the research is to show the learning of pre-service physics and chemistry teachers in a lesson study about tasks. The research methodology is qualitative and interpretive, with the participation of three pre-service physics and chemistry teachers. The data is collected through interviews and written reflections of the participants. The results show that pre-service teachers learn to identify tasks of different natures, valorizing open and challenging tasks in the development of students' competences. They also recognized that when students like the task they will become more involved with learning which allows for more meaningful learning in science. Thus, the lesson study in initial training seems to promote the development of professional learning of pre-service physics and chemistry teachers in the Portuguese context.
Keywords: *lesson study, professional development, science education, pre-service teachers, science tasks*.

Introduction

Current science teaching must develop through educational situations appropriate for the development of more informed and scientifically educated individuals, allowing for the engagement of its people in a more participatory and critical way (Anderson, 2010). To do this, it is necessary to have the active involvement of students in situations that capture their interests and allow them to develop various competences (NRC, 2015). In Portugal, these recommendations are expressed in the curricula of the physical and natural sciences, emphasizing constructivist teaching approach through which the teacher should provide educational experiences that take into account the interests and characteristics of the students (Galvão et al., 2001). This differs from the traditional teaching approach that teachers are accustomed to using. In fact, using challenging and open tasks that puts students at the center of their learning (Bybee, 2006) does not play a dominant role in science classes, where the manual is one of the most used resources by teachers. Due to their nature, the use of challenging classroom tasks such as problem solving or inquiry allows for the creation of environments characterized by strong student participation, questioning and sharing of ideas. This environment facilitates the development of more questioning and critical attitudes, necessary for a better understanding of science and its processes. As teachers are key elements in implementing the recommendations of a curriculum, it is imperative to find ways to bring together the

research in education and its practices (Sabel, Forbes, & Flynn, 2016). One possibility is the lesson study as noted in the literature as a process strongly linked to the teachers' practice, and promotes a situation analysis that allows teachers and pre-service teachers to become more competent in their profession (Fujii, 2016; Ponte, 2017).

Lesson study is a model of professional teacher development that originated in Japan and has been receiving attention from all over the world. In a lesson study, participants generally begin by identifying a problem related to students' learning about a curriculum topic and then devise a systematic and very detailed plan to search for the answers. This plan, built in the planning phase, involves the planning of an observed lesson; the realization of this lesson, called the research lesson; and the post lesson reflection, in which the students' results are discussed in depth, based on the evidence gathered during the lesson. The planning phase is the longest phase in a lesson study and plays a central role in the development of the didactic knowledge of the participants (Fujii, 2016).

Investigations in lesson studies with pre-service physics and chemistry teachers are scarce. However, the results are promising (Munthe, Bjuland, & Helgevold, 2016). Recently in Portugal, the first steps were taken in the investigation of lesson studies with pre-service teachers of mathematics (Ponte, 2017) and of physics and chemistry, with very positive results. This research continues this project with the aim of understanding the learning of pre-service physics and chemistry teachers in a lesson study about tasks.

Methodology of Research

This research is qualitative and interpretive based on naturalistic observation (Erickson, 1986) and is carried out during a curricular unit of the master's degree in physics and chemistry teaching, with three pre-service teachers participating (Catarina, Luís and Sara). This lesson study has two cycle of twelve sessions. The planning phase takes place over eight sessions, followed by the research lesson (session 9) and the post lesson reflection (session 10); the second cycle includes the second research lesson (session 11) and the respective post lesson reflection (session 12). In addition to the three pre-service teachers, also participating the project leader of lesson studies (João Pedro), the teacher of the curricular unit (Mónica), the teacher of the classes involved (Carla, cooperating teacher) and the researcher (Teresa). The lessons in which the tasks are applied (the diagnostic and about the topic in two research lessons) are taught by the cooperating teacher and the remaining participants in the lesson study are observers. Data is collected by participant observation, through individual interviews conducted at the end of the lesson study and individual reflections written by the pre-service teachers at the end of the planning phase.

Results of Research

During several sessions of the planning phase of the lesson study, tasks that pre-service teachers can propose to students are discussed with attention given to various aspects. For example, at some point in the second session the main differences between exercises, problems and investigations are discussed, based on a text about tasks of different natures. During this time, the pre-service teachers make some important

learning discoveries. For example, Sara notes that "*The analysis of this text [on the nature of tasks] has allowed us to understand the difference between research tasks, problem solving and exercises"* (Individual reflection) whereas "*in our day to day life we do not make this distinction"* (Interview). In fact, pre-service teachers are not familiar with challenging tasks, as Luís says, "*we are not, or I am not, I was not, too familiar with this application [teaching with tasks], I am more accustomed to traditional teaching, transmission, out there (laughs)"* (Interview).

Sometimes during the third session as the work continues to develop on the tasks and several different curricular topics of various natures are resolved, attention is given to what the students will be allowed to develop. The results show that pre-service teachers recognize the strength of the challenging tasks, namely that "*Tasks with greater openness allow students to develop cognitive competences as they include, in addition to substantive knowledge and reasoning, communication and different types of procedural knowledge (e.g., interpretation of figures, tables and graphics), as well as cooperative and collaborative work"* (Luís, individual reflection). Catarina highlights other promising developments from the tasks when she says that "*with a task it is possible to start teaching a new topic to the students without having been previously explained to them. In this sense, the intelligent application of good tasks, such as problem solving and inquiry by teachers, is a very useful tool for students as they are able to summon previous knowledge and build new knowledge from that"* (Individual reflection). By mentioning that the use of challenging tasks allows students to perform more meaningful learning, Catarina reveals important professional learning.

Following up the work developed with tasks sometime during the fourth session, the questions of the diagnostic task are discussed and applied by the cooperating teacher. These moments allow pre-service teachers to develop an understanding of this material. Luís makes this known when he clarifies the function of the diagnostic task: "*it is intended that the students construct their learning through the task [of speed of sound], not being done by the previous lecture, by the teacher's exposure of the contents. However, it is fundamental that the degree of the challenge is adjusted to the ability of the students to reach an answer. Therefore, on the one hand, being able to assess previous knowledge of speed while, on the other hand, being able to provide students with fundamental requirements for performing the task on the speed of sound, a diagnostic task was planned for this purpose"* (Individual reflection).

Indeed, as Luís mentions, the identification of students' prior knowledge with the diagnostic task is a central aspect. It allows the teacher to define appropriate strategies specific to the students so that they may progress in a more autonomous way when learning the topic.

In the sixth session, after the cooperating teacher applies the diagnostic task, the students' results are discussed. These moments, valued by pre-service teachers, are influential. Catarina, for example, "*With the analysis of the answers given by the students in the diagnostic task we get to know several types of resolution strategies used by the students for the same task, thus getting to know various forms of reasoning by the students. Observing all of these different types of resolutions, in my opinion, has proved very interesting"* (Individual reflection). In fact, Catarina values that the students followed different ways to solve the given problem. The knowledge Catarina developed about the students as well as knowing what the open and challenging tasks provide, is of extreme importance for her professional activity.

At some point during the eighth session, the task for the research lesson is elaborate. To do this, they begin by discussing tasks about the topic, with different characteristics, looking at options and some suggestions by the pre-service teachers. It is when Luís makes it known, "*I also remember that there was a discussion, more on the part of us students, relative to the group of teachers, on the question of whether or not to include the chart [in the topic task], but I continue to defend it, raising some additional difficulties, it is true, but it has the advantage of students' interpretation and therefore the task being a problem instead of an exercise"* (Interview). What pre-service teachers learn about the tasks of different natures allows them to diversify their teaching strategies and value the challenging tasks to students learning the topic. In fact, it is Luís's pleasure that the task for the research lesson is a problem-solving type even though there is a risk that students will not be able to solve it autonomously. It is important for pre-service teachers to practice teaching using challenging tasks so that they know the importance of the risks involved and learn how to deal with them, as we saw with Luís.

Conclusions

The eight planning phase sessions in this lesson study were a possibility for pre-service teachers notice important features of tasks that make them simple exercises or challenging tasks for the students. In fact, the pre-service teachers learning about the potential of challenging tasks, including the understanding that challenging tasks allow their students develop complex skills, the realization that students learn the topic with more autonomy, as well as the reasoning that students use when they perform the tasks. In addition, they also recognized that when students like the task they will become more involved with learning which allows for more meaningful learning in science. Thus, the lesson study in initial training seems to promote the development of professional learning of pre-service physics and chemistry teachers in the Portuguese context.

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SUPPORTING CONCEPTUAL LEARNING IN ORGANIC CHEMISTRY THROUGH SEMI-EMPIRICAL MOLECULAR MODELING: HEURISTICS OF DIELS-ALDER [4+2] CYCLOADITIONS FOR PREPARATION OF POTENTIAL TLR4 MODULATORS

Rafael Doležal
University of Hradec Kralove & University Hospital Hradec Kralove, Czech Republic
E-mail: rafael.dolezal@gmail.com

Natálie Karásková
University of Hradec Kralove, Czech Republic
E-mail: natalie.karaskova@uhk.cz

Nadezhda V. Maltsevskaya
Professional Education Institution, Russia

Karel Kolář
University of Hradec Kralove, Czech Republic
E-mail: karel.kolar@uhk.cz

Abstract

A vast majority of novices in universities predominantly utilize algorithmic mental processes to resolve assigned tasks and tests. Although algorithmic thinking is an essential part of human cognitive functions, experts on didactics call for methods, which develop also conceptual thinking in beginners. Currently, heuristic molecular modeling gains an important position in chemistry education since it inherently integrates several conceptual thinking principles. Herein, it is focused on computational analysis of eight potential immunomodulators prepared by Diels-Alder reactions to exemplify conceptualized chemistry learning.
Keywords: *conceptual learning, diels-alder cycloadditions, molecular modeling, RM1, activation energy.*

Introduction

Conceptual thinking with respect to chemistry education has been recently expressed by Holme et al. by several cognitive capacities ranking into higher analytic-synthetic and divergent layers of intelligence (Holme, Luxford, & Brandriet, 2015). Although development of higher mental operations is not straightforward, several approaches like understanding symbolic representations or heuristic learning techniques have been proposed to support conceptual thinking (Russell et al., 1997). In particular, heuristic techniques turn out to be very convenient for education, since they are oriented on students' experience, being based on analysis of the problem and proposition of simplified solutions *via* divergent thinking (Niaz & Rodriguez, 2000). These problem-solving methods are associated with conceptual operations, while employing practical handling such as defining simple rules, making schemes, keyword maps, models, intuitive judgments, and predictions. In fact, heuristics can be considered as an existential bridge between algorithmic and conceptual thinking. Regarding chemistry education, heuristic learning approach may be eloquently exemplified by molecular modeling, which provides students with realistic visual representations, gives them concrete examples for observation and, in the same time, it enables them to perform ambitious quantum-chemical calculations as well as to utilize trial-error methods to understand the system behavior.

In the present research, it is proposed eight tasks on preparation of potential of human toll-like receptor 4 (TLR4) modulators by Diels-Alder [4+2] cycloadditions (DACs) of maleinanhydride and maleinimide with anthracene substituted in the position 2 with: H, Cl, CH_3 and OCH_3 functions. Thus, the issue of the mechanism of DACs is addressed conceptually through semi-empirical molecular modeling in software Spartan 14. Students can visualize molecular level of reactants and products, observe their realistic structures, see the electron density, quantify interaction energies, and, finally, they can predict, to certain extent, the results of real experiments. The proposed semi-empirical quantum chemistry method RM1 enables to obtain optimized structures of all involved compounds, to calculate energies of occupied and virtual orbitals, to predict the activation energies of the reactions in gas and aqueous phases, to evaluate the effect of substituents in 2-position in anthracene on its reactivity with maleinanhydride and maleinimide, and to dynamically simulate the reaction pathways in reasonable time, corresponding to an education unit of 90 minutes. These eight examples of DACs provide a schematic outline for teaching organic chemistry conceptually with heuristic molecular modeling.

Methodology of Research

In order to support conceptual thinking by heuristic techniques, teachers have to urge students to exploit their imagination, to examine concrete examples, to guess possible solutions, and, importantly, to take courage in making ambition plans (i.e. to apply the Inventor paradox). Since in this brief report it is not possible to discuss neither the principles of heuristics in deep details, nor the subtle aspects of the DACs mechanism, only key steps in exposition of DACs problematic will be mentioned here. At first, undergraduate students have to be informed about the basic principles of DACs (e.g. a synchronous addition of a diene to a dienophile that generally involves interactions of

π electron systems). Then, students are directly confronted with the issue: let us have eight products of DACs; how would you simulate the forming processes to estimate the activation energies (Fig. 1.)?

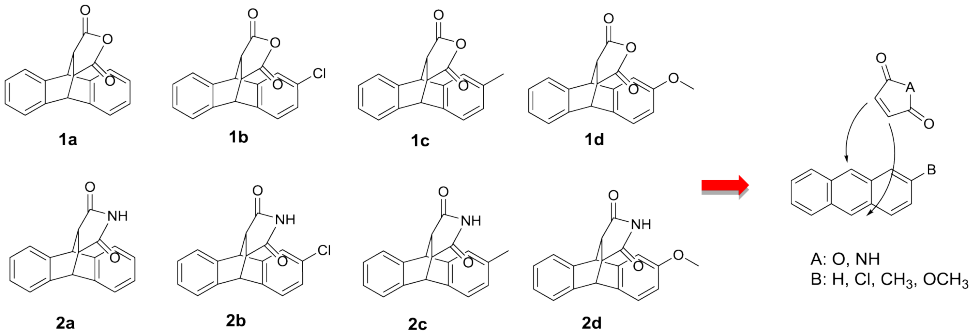


Figure 1: Overview of eight different products of DAC and deduction of the reaction mechanism.

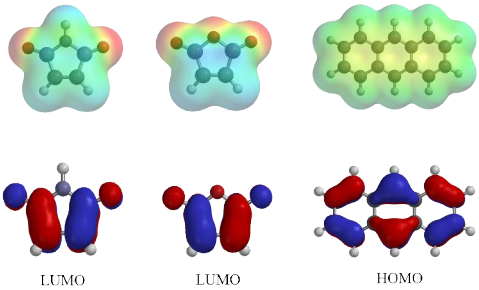
Having seen the structures of chemical products, students should be led by questions how to design appropriate reactants. Once they recognize that the products can be synthesized by linking anthracene and its derivatives with maleinanhydride or maleinimide, the consequent task is to propose the reaction mechanism, knowing that DACs is a simultaneous reaction between a diene (i.e. anthracene and its derivatives) and a dienophile (e.g. maleinanhydride and maleinimide). Next, students are exposed to basic principles of work with Spartan 14 program (e.g. drawing chemical structures, optimizing the structures, setting static and dynamic bond parameters, calculating energies of the highest occupied and the lowest unoccupied orbitals (i.e. HOMO, LUMO energies), setting the level of theory, calculating energy profiles, isodensity surfaces, electrostatic potential, creating tables with variables, plotting reaction coordinates, etc.). Since students can learn these simple operations very quickly from demonstrations, they can be asked to prepare step-by-step input models of all products **1a – 2d**. Then, students are instructed to perform following operations (Figure 2).
Draw the product structures

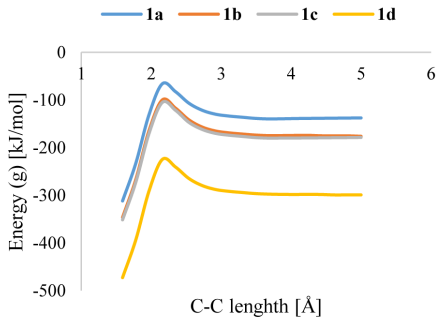
Figure 2: Formal steps in calculating the energy profiles of eight DACs by RM1 method.

The crucial step in simulations of these DACs is the idea that the products can be split into reactant by simultaneous extending the C-C bonds displayed in Figure 1 as curved arrows. If students are instructed to set both the forming bonds to assume length from 1.4 Å to 5.0 Å in regular 20 steps, they finally recognize in the resulting dynamical reaction models that extending these bonds is exactly the time reversed procedure of the bonds' formation. In the first exposition of this topic, students need not be informed

about the details that the underlying computational process consists in geometrical optimization by conjugate gradient with length restriction imposed on the selected C-C bonds. All the facts are implicitly demonstrated by the dynamical simulations of the reactions. After students successfully calculate the energy profiles, they are asked to export total energies in gas and aqueous phases and the length of one of the forming bond during DACs. From these quantities, they can construct the reaction coordinates and determine the activation energies as the height of the potential barrier between the reactants and the product. Finally, the students are asked to calculate the HOMO and LUMO energy for all the reactant molecules and observe the relationship between the HOMO (diene) – LUMO (dienophile) energy gap and the activation energies (Figure 3). All the resulting values should be discussed and interpreted. Since the heuristic approach can be well combined with *a posteriori* explanation, it makes no troubles in learning that students will get a complete insight into DACs gradually.

Product	Activation energy (g) / (aq) [kJ/mol]	HOMO-LUMO gap [kJ/mol]
1a	71.65 / 66.73	641.33
1b	76.21 / 71.25	662.79
1c	73.40 / 67.60	636.27
1d	74.35 / 66.08	628.74
2a	74.19 / 78.64	674.06
2b	76.20 / 81.84	695.52
2c	75.14 / 79.66	669.00
2d	76.29 / 75.99	661.47





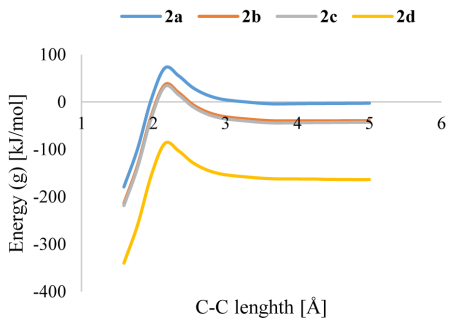


Figure 3: Models of reactants in selected DAC's, related properties and quantitative reaction characteristics.

Conclusions and Implications

The objective of the presented heuristic molecular modeling tasks is to lead students to simulate real chemical compounds and their reactions. One stage is to perform simulations of DACs by extending the length of the forming bonds in the products and to

determine the energy reaction profiles. The second stage is to determine the HOMO and LUMO energies for all the involved reactants. From the results, students can understand that DAC's are governed by the differences of frontier molecular orbital energies in the reactants, which are in a proportional relationship with the resulting activation energies. They can easily observe, especially in the case of aqueous environment, that malein-anhydride decreases the activation energies of DACs in comparison with maleinimide, while 2-chloro function in anthracene increases it. These effects can be explained by electron-withdrawing properties of the chlorine atom, which detracts the electron density from the reaction center and lowers the HOMO energy. Conversely, the nitrogen atom in maleinimide is a weaker electron density attractor than the oxygen atom in malein-anhydride, and causes relative increasing electron density in the reaction centers, which results in a higher LUMO energy, a greater HOMO-LUMO energy gap, and a larger activation energy. These DACs tasks enable chemistry students to develop conceptual thinking by visualization of the underlying molecular processes while utilizing convincing level of theory and modern powerful computer technologies.

Acknowledgements

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THE FORMATION OF THE ENVIRONMENTALLY DIRECTED THINKING AS THE NECESSARY QUALITY OF PERSONALITY IN MODERN CONDITIONS

Suriya Gilmanshina, Aygul Gayfullina, Iskander Gilmanshin
Kazan (Volga region) Federal University, Russia
E-mail: gilmanshina@yandex.ru, agajfullina@yandex.ru, is-er@yandex.ru

Abstract

It has been developed a conceptual model of environmentally directed thinking and its relationship with environmental protection on the basis of competence approach. It have been developed the principles of formation of the environmentally directed thinking in the structure of environmental competence. There were proposed stages of teacher's activity by the gradual transition from mental activity of students with a reproductive level to the level of creative environmental activities. The technology of problem-based learning based on interdisciplinary links was highlighted. A new look was justified at the environmentally directed thinking as an essential quality of the personality of modern man and the backbone factor of education of intelligence and civilization, ecological attitude to nature.
Keywords: *ecologically oriented thinking, environmental competence, problem-based learning.*

Introduction

In accordance with the modern world conception of environmentally sound and sustainable development of society which provides the education of youth a new mindset, it becomes important to the formation of their environmentally directed thinking. Ecologically oriented thinking contributes to the development of an internal sense of responsibility and duty for the conservation of the human environment as the most important category in the system of social values. Ecologically directed thinking is a systemic neoplasm and is formed in the course of the environmental activities of man.

The problem of the organization of environmental work in theory and practice of environmental education is built on nurturing the personal qualities and it is systemic. The personal qualities which contribute to the successful formation of the psychological readiness of man to environmental work are considered in a coherent manner. Thus, according to the scientists (Deryabo, Jasvin, 1996; Lamanauskas, Augiene, 2017; 2016; Likhachev, 2003; etc.), there is a need of focus on positive attitude (motivational readiness); a high level of arbitrariness of conduct (volitional preparedness), i.e. the ability to engage in a task in environmental protection, to plan and control their actions; availability of environmental knowledge and skills (educational readiness); the development of qualities

that ensure the ability to establish team relationships (communication readiness). Since environmental work is a psycho-pedagogical and socio-economic problem, it has its own peculiarities, according to the vector city – village.

Thus, solving the questions of environmental education should be considered as first priority goal of the organization environmental activities with the aim of forming environmentally directed thinking based on the realities of today. The study of the environmentally directed professional thinking of the teacher (Gilmanshina, Sagitova et al., 2015) showed that its formation has to be systemically. Some aspects of systems thinking are considered in (Broks, 2016). However, there cannot be found works devoted to the investigation of regularities of environmental activities in the village for the purpose of forming by students environmentally directed thinking. Today is important a new perspective on the environmental work of young villagers as on the competence, but on the environmentally directed thinking as a necessary quality of the personality of modern man.

The purpose of the research was to develop the principles of formation of the environmentally directed thinking in the structure of environmental competence.

Methodology of Research

A leading approach to the study of this problem is a competence approach that allows considering the problem of general cultural and subject training of students, to focus education towards personal development, growth. The crucial categories of the competence approach in education are "competencies" and "competence". In our studies, we rely on the following definitions. Competencies as person's ability to meaningful implementation of a particular kind of activity should include appropriate knowledge, skills, ways of thinking, reflection, self-awareness, and should be characterized by the degree of mastery of the defined competencies. Competence is the aspect of the activity, which should be formed in educational institutions (Gilmanshina, Sagitova et al., 2015). This article does not address professional competence as a characteristic of a person, such as the ecologist. We are talking about the competence, hirable for the realization of publicly available environmental action of Russian citizens.

Results of Research

Ecologically oriented thinking we see as the most important personal quality that is essential for humans, because ecological orientation of the person in science understands as a personal quality and it is about the formation of personality. This fact and all the above-mentioned require consideration of essence of environmental competence and the principles of the formation of environmentally directed thinking in the structure of environmental competence.

Environmental competence, from our point of view, reflects the natural and environmental and legal literacy, moral principles, citizenship, spirituality and the environmentally directed thinking. The moral aspect of environmental competence is in the actions aimed at protecting the environment. Citizenship is related to the recognition of a nationwide affiliation of nature. Formation of moral and civic environmental competence is inextricably linked to the growth of caring about nature, clean water

sources, conservation of topsoil, the suppression of acts detrimental to the environment. Organized actions in defense of nature should lead young students to spirituality and understanding the value of natural-science knowledge. Comprehension of the beauty of the environment should engender a desire to protect the environment, commitment to relevant environmental and legal actions.

Sustainable links that determine the nature of environmental competence allows to identify the role of the environmentally directed thinking in the structure of environmental competence. Environmental competence we consider as ability of the person with the environmentally directed thinking to actively use the scientific and ecological and legal knowledge in conservation of nature and as a social characteristic of a person, a citizen with high spirituality and morality, based on creativity and cultural growth.

Developed conceptual model of environmentally directed thinking as the unity of scientific thinking in the natural Sciences and practical thinking in the field of environmental activities allowed us to formulate principles of formation of the environmentally directed thinking in the structure of environmental competence.

The first principle is the principle of didactic interpretation of the logic and methods of natural science the sciences used in educational institutions. Its essence in the application of the principles of didactics taking into account actual capabilities of students, using specifically designed educational tasks of the disciplines.

The second principle is the training the moral, environmental and legal environmental management, taking into account psychological laws of mastering of system of ecological concepts by pupils. The essence of the second principle is the use of integrated courses aimed at the formation of the environmentally directed thinking, and system of a problem ecological and legal problems and tasks with reflection of moral contradictions, problems, and concepts in rational use of natural resources system, and also in teaching the logic and methods of the description, explanations of the studied phenomena and their prediction, research techniques.

The third principle is the propaganda of active working life for the study and nature conservation (propaganda activities, greening schools and settlements, restoration and protection of forests, protection of soils from erosion, protection of useful insects, protection and attraction of birds, protection of bodies of water, etc.).

Since the environmentally directed thinking is a multi-component personal education with a complex structure, insofar its formation is a long process of gradual implementation of a number of interrelated sub-goals. Today in conditions of competence approach in education in an invariant of the system of intermediate objectives is the requirement of gradual transition of intellectual activity of pupils from the reproductive level to the level of creative nature protection activity. This transition is associated with the following stages in teacher's activity: developing student’s skills to analyze and summarize the experimental data; training a logical explanation of science theories and definitions; put thoughts out, hypotheses on the solution of the educational environmental problem; training in the solution of real complex environmental tasks and critical self-assessment. (Read more in Gilmanshina, Gilmanshin et al., 2016; Gilmanshina, Gilmanshin, 2015; Galimov, 2007.)

Among the didactic methods and technologies, providing efficient targeted development of environmentally directed thinking in the structure of environmental competence of students, we highlight the technology of problem-based learning on the basis of intersubject connections.

Conclusions and Implications

In conditions of competence approach to form students' environmentally directed thinking is influenced by the sources of knowledge (socio-cultural, scientific and applied environmental science) taking into account the criteria of selection of educational material. It have been developed the principles of the formation of environmentally directed thinking in the structure of environmental competence.

Thus, for the formation of students' environmentally directed thinking in the structure of environmental competence, the teacher needs to use teaching technologies to ensure the unity of natural science and environmental law education, moral, civic labor, spiritual and aesthetic education. There is important a new look at the environmentally directed thinking as an essential quality of the personality of modern man and the backbone factor of education of intelligence and civilization, ecological attitude to nature.

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STUDENTS' INTEREST IN THE SCIENCE SUBJECTS AND MATHEMATICS IN SCHOOLS OF LATVIA AND LITHUANIA: A COMPARATIVE STUDY

Ineta Helmane, Dagnija Cēdere
Riga Teacher Training and Educational Management Academy, Latvia
E-mail: dagnija.cedere@lu.lv

Vilija Targamadze
Vilnius University, Lithuania
E-mail: vilija.targamadze@fsf.vu.lt

Inese Jurgena
Riga Teacher Training and Educational Management Academy, Latvia
E-mail: inese.jurgena@rpiva.lv

Abstract

Interest is one of the most meaningful components for successful learning process. Nowadays students' interest about science and mathematics is decreasing. The aim of the study is to explore the interest of Grade 9 students in science and mathematics. In Latvia and Lithuania students were surveyed and it helped to explore the respondents' interests in science and mathematics. The survey shows that students have rather pronounced interest to explore and solve problems connected with the real life.
Keywords: *interest in science, learning process, science and mathematics*.

Introduction

During the last decade all European countries have reformed the education contents (Science Education in Europe, 2011), because science taught traditionally at school does not provoke interest in students about nature mainly because they do not see the link between the science with their own life and interests (Aikenhead, 2005). The students' little or decreasing interest in science is partly defined by the fact that science is taught as if remotely, including content-wise invaluable facts that are unrelated to pupils' own experience (Sjøberg, 2002; Osborne, Simon, & Collins, 2003; Aikenhead, 2005).

Interest is a central precondition for intrinsic motivation (Krapp, 2002; Schiefele, 1991) and it is essential to maintain motivation over time (Sansone, Wiebe, & Morgan, 1999; Uitto, Juuti, Lavonen, & Meisalo, 2008) Interest emerges from individual interactions with his or her environment (Arikpo & Grace, 2015). Individual interest refers to an individual's relatively enduring psychological predisposition (preference) to re-engage in particular classes of objects, events, or ideas over time and is content-specific (Hidi & Harackiewicz, 2000; Hidi & Renninger, 2006; Arikpo & Grace, 2015).

Interests have been identified as important construct that influence students' engagement and accomplishment in learning (Chen & Shen, 2004; Arikpo & Grace, 2015) Interest-triggered learning activity leads to a higher degree of deep level learning (Krapp, 2002; Uitto, Juuti, Lavonen, & Meisalo, 2008). Interest has been found to play a key role in influencing student learning behaviour and intention to participate in the future (Chen & Darst, 2001; Arikpo & Grace, 2015). It is characterized by their learning motive (why pupils learn), and learning strategy (how they learn). It represents a specific relationship between the developing person and some content of his or her life-space (Arikpo & Grace, 2015).

The student's desire to learn or the interest develops in the interaction of the significance of the object (value) and experience. More successful teaching/learning process is possible with evocation of interest (Cedere, Jurgena, & Helmane, 2015). In order to understand how to solve this long-drawn problem about the lack of young people's interest in science and mathematics the following research questions were put forward:

- Do Grade 9 students learn science subjects (biology, chemistry, and physics) and mathematics with interest in Latvia and Lithuania?
- What is students' action and activity in science subjects and mathematics in Latvia and Lithuania?

Methodology of Research

This research was carried out in period 2015 - 2017 in Latvia and Lithuania. Data were collected from different basic schools and secondary schools in different regions of Latvia (LV) and Lithuania (LT). The total number of voluntarily chosen students as respondents is 536 in Latvia and 454 in Lithuania. The average age of respondents is 15.3 years according to the class records.

The research was based on students' survey that describes interest of respondents in science subjects (biology, chemistry, and physics) and mathematics. The questionnaire of the survey is based on the studies performed earlier (Mozeika & Cedere, 2008; Gedrovics & Cedere, 2014; Cedere, Jurgena, & Helmane, 2015). The questionnaire was designed in an electronic version as link on Google disc. Students answered to questions electronically in internet. The questionnaire comprises questions where the answer variants correspond to four value Likert scale and are coded: 1 – no, 4 – yes. The questionnaire data were grouped and analysed according to previously defined research criteria according to the intensity of the students' action and activity in the teaching/learning process.

The data analysis was performed using the statistical software SPSS program. The reliability (inter-item consistency) of the questionnaire according to Cronbach alpha coefficient was .916.

Results of Research

The results of students' survey testify that students' interest in science subjects is not high. The questions *Do you think with pleasure about the lessons of biology / chemistry / physics / mathematics?* were answered positively (*yes and rather yes*) about

biology by 28% and 36.2%, about chemistry by 18.4% and 28%, about physics by 19.2% and 31.8%, about mathematics only by 24.8% and 28.2% of respondents.

Latvian and Lithuanian students' answers on survey questions are similar in general. Students think with pleasure about biology in Latvia and Lithuania (Table 1). Data analysis from boys and girls allows understanding the respondents' interest in science subjects and mathematics. Girls think with more pleasure about biology (M = 2.89), least subject is physics in girls' choice (M = 2.28). Boys prefer mathematics from science subject list (M = 2.85), they choose chemistry as the last one (M = 2.53).

Table 1. Students answers to a questionnaire by countries.

Items	Country	N	Mean	Std. Deviation
Thinking with pleasure about the lessons of biology	LV	516	2.90	0.905
	LT	409	2.72	1.023
Thinking with pleasure about the lessons of chemistry	LV	510	2.52	0.987
	LT	423	2.49	1.097
Thinking with pleasure about the lessons of physics	LV	508	2.59	0.980
	LT	424	2.32	1.092
Thinking with pleasure about the lessons of mathematics	LV	502	2.69	1.037
	LT	433	2.77	1.125

Chemistry and physics decoupling with interest approved by respondents' positive answers (21.5%) to the question: *Would you like to choose the difficult but personally interesting tasks in chemistry and physics lessons?* In this case also there are no distinct differences between the Latvian students' answers (M = 2.46) and the Lithuanian student answers (M = 2.63). While the students' willingness to solve complex tasks, practice related problems: in mathematics students (28.2%) desire to solve interesting but challenging tasks is little pronounced and application of mathematics is of no particular interest. In Lithuania pupils have more desire to learn mathematics, it is a statistically significant difference: t (910) = 10.386, p <0.001, a = 0.95.

In Latvia and Lithuania students' action and activity in the teaching/ learning process evaluate as contradictory. It was characterized by the answers to the following questions: *Do you suggest what more could be done in science and mathematics?* 8.9% answered positively and *Have you tried to ask the teachers while doing sciences and mathematics?* 15.4% answered positively. Whereas, students' positive answers (24.1%) on question *Do you always follow the biology, chemistry, physics and mathematics, and the execution of all tasks?* can be argued that students not always follow the lessons and do all the tasks and seldom tell the teacher what to do in the lessons. Students' interest to explore is not pronounced and does not possess perseverance to finish what has been started is significantly different in Latvia (M = 2.56) and Lithuania (M = 2.02); t(910) = 8.148, p < 0.001.

Low level of students devoting free time to mathematics and science – boys (M = 1.81) and girls (M = 1.89) spend very little free time on science and mathematics. It testifies that students devote very little of their free time to the exploration of nature and the acquisition of the sciences; the students' interest is not deep enough and stable. This affects the willingness of students to learn the future profession in science and mathematics. Only 19.3% respondents are open to learn a scientist or mathematician professions in future.

Conclusions

Students' interest in science and mathematics is not to be found a significant difference between Latvian and Lithuanian students. The similarities were found in students' responses from both countries. Students, especially girls, like biology lessons the most, while boys display higher interest in mathematics. The liking towards the lessons in the respective subject on the mean assessment corresponds well to the respondents' interest and understanding about the importance of this branch of science. On the whole, respondents' interest in science subjects and mathematics can be assessed as medium; still it is very different and is paced in a wide range as regards particular students. The attention is drawn to the fact that relatively many students have explicitly low interest in the science subjects included in the study.

Opinions expressed by respondents allow concluding that in order to promote higher interest, teachers have to use teaching approaches and strategies thus actualizing students' action and evoking students' activity in science and mathematics teaching/learning.

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SCIENCE EDUCATION IN SOUTH AFRICA: ENGAGING THE NEW GENERATION OF STUDENT TEACHERS IN SERVICE-LEARNING FOR SUSTAINABLE DEVELOPMENT

Angela James
University of KwaZulu-Natal, South Africa
E-mail: Jamesa1@ukzn.ac.za

Abstract

Amidst student calls for a 'Decolonised curriculum" and "Fees must fall" a renewed education is required. The research question - How students registered for a Service-Learning and Sustainable development focused module were challenged? 88 students, with 47 community based projects were engaged in the module. An interpretive paradigm with an exploratory, qualitative approach was used. Data gathering methods included class discussions, document analysis, visual methodologies and reflective diaries. The data analysis was deductively analysed. Students experienced great emotional and cognitive waves where social learning influenced their deep-learning, perceptions of themselves and the community and the actions to be taken.
Keywords: *service-learning, student teachers, sustainable development.*

Introduction

The demands and changes in the 21st century have pervaded education systems, globally. The education required is one that prepares students to be citizens, capable of participating in a technologically oriented economy with an advanced level of knowledge and application of varied skills. Educating students for the 21st century, in Higher Education in South Africa requires a renewed way of engaging students in learning experiences. Student calls for a 'Decolonised curriculum", an "Africanised curriculum", within the context of "Fees must fall", student strikes and actions, and civil society strikes re service delivery and other social and political matters bears a deeper purpose and rationale for an education of a difference for South African staff and students at Higher Education Institutions. Service-Learning in South African universities has been encouraged to take a leading role in developing and transforming communities (Department of Education, 1997). Quality Science and Technology education is vital in today's dynamic global economy and knowledge based society of the 21st century. But, this quality education cannot be amiss of the moral, social and identity construction and mindfulness (Moodley, 2016) of the engagements that students encounter. According to Eyler, Giles and Braxton (1997), when students are engaged in Service-Learning they have a positive development in their attitudes, values and a better understanding of social

issues. How students registered for a Service-Learning and Sustainable development focused module were challenged?

Methodology of Research

An interpretive paradigm with an exploratory, qualitative approach was used. The exploration of student challenges of the curriculum content; the teaching quality and the assessments of the module in the construction of their moral, social and identity construction was the interpretation to be made. 88 students in the module decided on their placement sites and the focus of their Service-Learning. The sites that they worked in included both the university and community settings. So, the data gathering methods included class discussions, document analysis, visual methodologies and reflective diaries of their work in the communities. The data analysis was deductive in line with the challenges with the curriculum; teaching and learning strategies and the assessment.

Results of Research

The results focus on the module content where students learn about research and Service-Learning and then conduct research on their Service-Learning in the community settings. The decisions about what topics to work with and where to work are expressed by: We have gone to so many places and we still have not found a suitable place; we went to a centre where we were welcomed; I cannot do this, I think it is too much time and effort I need to de-register.

Responses to the teaching and learning strategies concerned the classroom and field settings. The use of videos, class discussions and the sharing of your peers' concerns and experiences helped us to decide on the actions that we could work with in our sites. The expectations for us to conduct service in the sites seemed very daunting at first, but we did it.

Responses to the assessment included – this was my first time developing a PowerPoint presentation and then to present it to the class, I was so nervous at first, but indeed I can do it. The take-home examination had very different types of questions, and even though we had two weeks to complete it, I found that the critique question expected us to understand the Service-Learning steps, properly.

Conclusions and Implications

Students experienced great emotional and cognitive waves where social learning influenced their deep-learning, perceptions of themselves and the community and the actions to be taken. Student engagement in Service-Learning leads to valuing of; questioning about and taking action to make a difference in the lives of the students and the community that they are engaged with. Developing and transforming staff, students and communities for the 21st century and an education for making a difference, three elements must be considered, nationally. A relevant, meaningful and mindful curriculum where teachers and student teachers are meaningfully engaged in community focused action, revolutionary teaching and learning engagements and assessment that is inclusive of varied methodologies, and for development.

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DIDACTIC CAPACITY OF SELECTED CZECH AND RUSSIAN SECONDARY SCHOOL TEXTBOOKS OF ORGANIC CHEMISTRY AND THEIR MUTUAL COMPARISON

Natálie Karásková, Rafael Doležal
University of Hradec Kralove, Czech Republic
E-mail: natalie.karaskova@uhk.cz, rafael.dolezal@gmail.com

Nadezhda Maltsevskaya
Professional Education Institution, Russia

Karel Kolář
University of Hradec Kralove, Czech Republic
E-mail: karel.kolar@uhk.cz

Abstract

In the research, a quantitative method intending to evaluate didactic capacity of four textbooks of organic chemistry used at upper secondary schools has been applied. Focusing on the arrangement of verbal and non-verbal elements, two Czech textbooks of organic chemistry were compared with two adequate Russian textbooks. The textbooks were characterized by coefficients of subject presentation, education control, orientation, and the total didactic capacity. Based on chi-square statistics, significance of the results is discussed and critically interpreted.
Keywords: *didactic capacity, analysis of textbooks, educational mean, Czech and Russian textbooks, organic chemistry*.

Introduction

Currently, high-quality textbooks, as a didactic resource, remain a very valuable component of educational process, despite increasing penetration of information technologies into the curriculum, for example in the form of e-learning, interactive whiteboards, readers and tablets. High demand for textbooks is reflected by broad market, offering plethora of different textbooks. However, this diversity can lead to disorientation of mainly young teachers, who face a difficult decision about which textbooks have sufficient didactic capacity and are, thus, appropriate for education (Průcha, 1998). In the Czech Republic, application of textbooks in education is not conditioned by any official approval clause by the Ministry of Education Youth and Sports. In this respect, Czech teachers are free to select textbooks at their own discretion regardless of the approval of Ministry of Education Youth and Sports. In the Russian Federation, the situation is different, since teachers can use in the classroom only textbooks that meet the requirements of the Ministry of Education.

The aim of the research is to determine and quantify the degree of didactical capacity of two selected Czech and two Russian organic chemistry textbooks in order to estimate their suitability for education. For expressing the didactic capacity of the textbooks, a set of five coefficients was utilized: 1) coefficient of subject presentation (EI), 2) coefficient of education control (EII), 3) coefficient of orientation (EIII), 4) nonverbal coefficient (Eo), 5) verbal coefficient (Ev), from which the total didactic capacity E was calculated. Employing these criteria, the selected Czech and Russian organic chemistry textbooks have been described and the resulting data statistically processed utilizing contingency tables and χ^2 criterion. Herein, the zero hypothesis (H_0) was stated as follows: didactic capacity of the selected Czech and Russian textbooks is the same. As the alternative hypothesis (H_A), a statistically significant difference between didactic capacity of the selected Czech and Russian organic chemistry textbooks was postulated. The statistical outcomes and suitability of the proposed methods are critically discussed and possible improvements are suggested.

Methodology of Research

The method for analyzing didactic capacity assumes that textbooks are structural systems, composed of 36 components, each of them having its indispensable didactic function. To illustrate the method, the individual components of textbook didactic capacity can be simply classified into three main groups based on their didactic characteristics. Except from the coefficient of orientation, each of the groups is subdivided to verbal and nonverbal parts (Figure 1) (Průcha, 1998).

The principle of the method is to count all the present components of didactic capacity EI, EII, EIII, Eo and Ev in particular textbooks and to compare the frequencies by means of χ^2 statistics for contingency tables. For example, EI indicates, how many of these elements are present in a textbook: simple explanatory text, explanatory text illustrated by schemes or tables, overall summary of annual curriculum, summary for individual topics, summary of knowledge from previous courses, supplementary data, footnotes and comments, legends for graphics, glossary, artistic illustrations, schematic illustrations, photos, maps and diagrams, colored presentations. If a textbook has all these elements, it is scored EI = 14, resp. EI (present) = 14, EI (missing) = 0. Analogically, differences between selected textbooks can be evaluated for each individual didactic capacity coefficient EI, EII, EIII, Eo and Ev, or for the total didactic capacity E, which is the summation of all the coefficients.

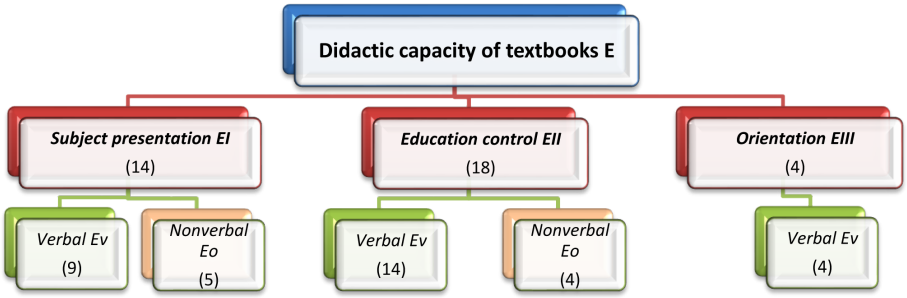

Figure 1: Didactic capacity of textbooks, its sub-categories and number of components.

If the total didactic capacity E should be evaluated for groups of textbooks, the frequencies of the individual elements' presence/absence are simply added within the group, placed into a contingency table and evaluated by χ^2 statistics (Table 1).

Table 1. Contingency table for the total didactic capacity E and χ^2 statistics.

Group	Present elements	Absent elements	Totals
Textbooks A	a	b	a + b
Textbooks B	c	d	c + d
Totals	a + c	b + d	a + b + c + d = N

$$\chi^2 = \frac{N(ad - bc)^2}{(a+b)(c+d)(b+d)(a+c)}$$

If the probability of the resulting χ^2 statistics for given degree of freedom is lower than 0.05, we can reject H_0 saying that textbooks A and textbooks B are of the same didactic capacity. Alternatively, in the case of 2 x 2 contingency table, H_0 can be rejected if the resulting χ^2 statistics is greater than 3.841, which corresponds to the tabulated critical χ^2 for 1 degree of freedom at the level of p = 0.05.

Results of Research

For students, secondary school textbooks remain a valuable source of information. Therefore, the present analysis of didactic capacity focused on secondary school textbooks dedicated to organic chemistry. According to our best opinion, two representative Czech and two Russian organic chemistry textbooks were selected to evaluate the methodology for the estimation of didactic capacity. The main criterion for the selection of the school textbooks was the fact whether they have the approval clause, which is granted by the Ministry of Education, Youth and Sports (Ministerstvo školství, mládeže a tělovýchovy) or Ministry of Education and Science (Ministerstvo obrazovaniya i nauki) in the case of Russian textbooks. The list of approved textbooks, which meet the official criteria, is published and regularly updated on the website of the Czech and Russian Ministry of Education www.msmt.cz and www.минобрнауки.рф. It is necessary to note that the secondary school textbooks by Rudzitis and Feldman and Gabrielyan used in Russia meet the requirements of the Ministry. However, among the selected Czech organic chemistry textbooks, only textbooks by Kolar et al. fulfil the criterion. Selection of the textbook by Mareček and Honza was based on its frequent use in secondary schools (Klečka, 2011).

The analyses of the total didactic capacity E of the selected Czech (Kolář et al., and Mareček and Honza) and Russian (Gabrielyan, Rudzitis and Feldman) organic chemistry textbooks for secondary school are summarized in Figure 2.

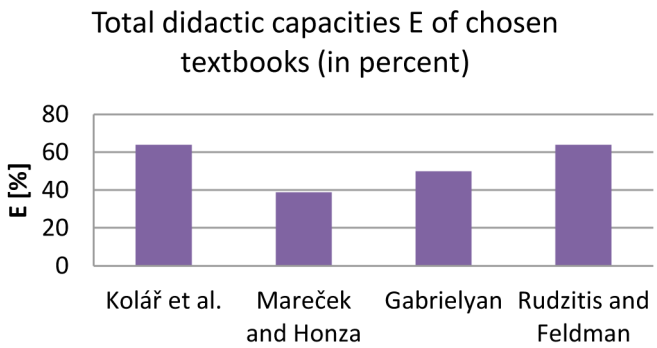

Figure 2: Characterization of the selected Czech and Russian organic chemistry textbooks for upper secondary school.

Particularly attention was given only to the analysis of the total didactic capacity of the selected textbooks. The Czech textbook by Kolář et al. was scored with E = 63.89% and by Mareček and Honza E = 38.89%. The Russian textbooks by Gabrielyan gained E = 50% and by Rudzitis and Feldman E = 63.89%. From the presented results, it can be easily deduced that the top scored Czech textbook of organic chemistry is the one by Kolář et al. In the case of the Russian high school chemistry textbooks, the one by Rudzitis and Feldman is best didactically equipped, with the coefficient of the total didactic capacity E equal to the value of the Czech textbook by Kolář et al. The Czech secondary school textbook by authors Mareček and Honza seems to be not sufficiently didactically equipped, although its exploitation in schools is widespread.

Comparison of the total didactic capacity E of the selected Russian and Czech secondary school chemistry textbooks was performed using χ^2 statistics. However, the resulting $\chi^2 = 0.5134$ does not exceed the tabulated value on the level of significance of 0.05 for 1 degree of freedom 3.841, which means that there is no statistically significant difference between the two groups. Thus, the H_0 cannot be rejected in this case.

Conclusions and Implications

The presented analysis provides an overview of the total didactic capacities of the selected Czech and Russian secondary school textbooks of organic chemistry. The research survey shows that the most didactically equipped Czech textbook of organic chemistry is the grammar school textbook by Kolář et al. The textbook by Mareček and Honza was scored lower than the textbook by Kolář et al. in the evaluation of didactic capacity, which is somewhat related with the fact that this textbook lacks the approval clause. The best didactically equipped Russian textbook was the one by Rudzitis and Feldman. If we compare the Czech and Russian textbooks by the method for the total didactic capacity based on contingency table and χ^2 statistics, we can conclude that there is no significant difference between these two groups of textbooks.

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IMPLEMENTATION OF GEOMETRICAL CONCEPTS IN KINDERGARTEN

Anna Klim-Klimaszewska
Siedlce University of Natural Sciences and Humanities, Poland
E-mail: klimanius@interia.pl

Stanisława Nazaruk
Pope John Paul II State School of Higher Education in Biała Podlaska, Poland
E-mail: s.nazaruk@dydaktyka.pswbp.pl

Abstract

The core curriculum of preschool education stipulates that the child that is prepared to study Mathematics in school can distinguish between basic geometric figures (circles, squares, triangles, rectangles). Nevertheless, a review of the records of student training in preschool revealed that there were no geometry-related subjects in any of them. Therefore, it was decided to further investigate whether it was the teachers who did not implement geometrical concepts or just the students, who had no opportunity to observe or conduct classes in the field. In addition, if the latter was the case, the analysis was to include the extent to which teachers implement geometric concepts.
Keywords: *geometry teaching, preschool education, child development.*

Introduction

It is generally acknowledged that geometry should be first taught between the age of 6 and 7, when actions which limit themselves to the child's mind begin to form.

However, both research and pedagogical practice indicate that as early as at the pre-operational stage, i.e. in children aged 2-6, "geometric intuition" begins to appear. It develops in little children through everyday hands-on experience.

Eagerness of children to poly-sensory explore everything that surrounds them is untiring. As it also refers to different objects, children very quickly develop the ability to distinguish between individual shapes. The child observes, touches, moves, turns round, changes the shape etc. Then, the child's mind goes on to isolate the most important factors (Gruszczyk-Kolczyńska, Zielińska, 1997, p. 127).

An average-level two-year old can fit various shape plates to holes in a small plank (circles, squares, triangles). In his third year, the precision in observing shapes increases enough for the child to be able to draw a circle or a loop, or differentiate between an ellipse and a cylinder shape (Hurlok, 1996, p. 496). A typical four-year old can draw not only a circle but also a square. At the age of five, the ability to distinguish between individual figures is even better. Six-year olds, in turn, accept geometrical shapes, such as circles, squares, triangles, etc. as characteristic features of existing and recognisable things. (Franus, 1975, pp. 60-61). Thus, a preschool child may successfully learn geometry.

Methodology of Research

Bearing in mind the importance of geometric education in the child's life and taking into account the lack of publication from research describing this issue, it was stated that it is an important reason to carry out this kind of research. The main aim of the research was to establish what topics from the geometry are implemented by the teachers of kindergartens.

A total of 150 teachers (females only) from Siedlce and Biała Podlaska kindergartens were surveyed. The teachers taught in groups of 3-, 4-, 5- and 6-year old children. All teachers held a university degree. The method used in the study was a diagnostic survey. The method was implemented by the analysis of documents (records). The research included diaries of preschool activities and monthly plans of work for the period September 2016 – April 2017. In addition, with the teachers conducted individually interviewed to verify and supplement all materials collected during the analysis of the records.

Results of Research

Research has shown that the teachers implemented the following geometry-related topics: 1. Colourful puppet clown - a flat, colourful paper cutout composed of geometric figures, 2. Circle-shaped objects - a didactic game, 3. Distinguishing the circle shape - a game using colourful small circles, 4. Circles and little circles - a Mathematical game, 5. Button puzzles - looking for circles in the room, 6. Reconstructing the shapes of geometric figures, 7. Making balls out of newspapers, 8. Square - games involving geometric figures, 9. Which ball is bigger? - a Mathematical game, 10. Let's make snowballs - an outdoor activity, 11. Cutting out along a straight, broken or a curved line, 12. Consolidating shapes and names of geometric figures, 13. Artistic works composed of geometric figures, 14. Introducing children to the ruler as a geometrical tool, 15. Introducing children to the straight and broken line, 16. Looking around for the recognised shapes, 17. Colourful signs - distinguishing between shapes in road signs, 18. My dream car - cutting out shapes, adding elements in the shape of geometric figures, 19. Ball - introducing children to the sphere, 20. Building using large spatial blocks - using the term "cube", 21. Sphere or circle - finding differences, 22. Making patterns of geometric figures, 23. Rhythms - making rhythms of squares, circles and triangles, 24. Revision of characteristic features of a square, triangle and a rectangle, 25. Is it ... - distinguishing a square from a rectangle, 26. Making paper balls, 27. Finding shapes of plane and solid geometric figures in everyday objects, 28. A triangle fairy tale - a Mathematical story, 29. Road signs and geometric figures - a Mathematical game, 30. Making any spatial compositions of blocks in the shape of geometric figures, 31. Let's make a snowman and a house for the winter - a spatial game, 32. Consolidation of names and appearance of geometric figures, 33. Circle and sphere - plane and solid figures, what makes them different? 34. Colourful circles - playing with circles, 35. Creating a snowman silhouette using circles, 36. Paper Christmas tree - origami technique using circles, 37. Chasing the square - games and exercises, 38. Triangles - a game involving physical movement, 39. Getting to know the rectangle - introducing the name and features of the rectangle, 40. Obedient figures - a game consolidating recognised geometric figures, 41. Sorting

figures - a game, 42. Making silhouettes of fairy tale characters using geometric figures, 43. Counting figures - adding practice, 44. Games involving geometric figures, 45. Making patterns using geometric figures.

These topics were recorded in the case of 23 teachers. In the study period, the teachers covered a maximum of four different subjects. All teachers introduced the following topics: artistic works involving the use of geometrical figures, making patterns using geometric figures, making a snowman silhouette using circles. The analysis has revealed that the teachers implemented themes associated with geometry on average once per two months.

In the case of 65 teachers, no geometry-related topics were recorded but their monthly work plans included sub-themes involving, among other things, objectives regarding geometric concepts, such as (due to the editing limits, only a sample has been provided) no. 1. Subject: I can add a few and subtract a few. Operational objective: Child: adds and subtracts a few using square-, triangle- and pentagon-shaped cards. 2. Subject: Homes during winter time. Operational objective: Child: puts squares in a row and triangles above them. 3. Subject: Daisies live in the grass. Operational objective: Child: folds circles, makes a daisy using them. 4. Subject: Arranging calendars: "Seasons of the year". Operational objective: Child: arranges a calendar using colourful circles and reads. 5. Subject: Bees and ladybirds in the meadow. Operational objective: Child: folds circles, makes a bee and a ladybird using them. 6. Subject: Mathematical games with a teddy. Objective: skilful recognition of plane geometric figures. Such objectives were found on average in 2 lesson scenarios. In the interviews conducted with the teachers, they claimed that establishing one geometrical objective when implementing other pre-school education themes was completely sufficient to satisfy the requirements of the core curriculum.

In the case of 62 teachers no subject or objective which would indicate implementation of geometry-related topics was recorded. When interviewed, the teachers admitted that the curricula they were using contained concepts related to recognising basic plane and solid figures, in line with the core curriculum; however, methodological guides provided for no ready-to-go scenarios for lessons which would have them introduced. Therefore, they tended to skip such subjects.

Conclusions and Implications

Research has shown that the majority of the study preschool teachers conduct no systematic Mathematical education with regards to geometry. Teachers who implement geometrical concepts limit them to introducing the core curriculum requirements. But helping children shape their geometric intuition is an essential element of education. After all, such activities develop child's imagination, memory, operational thinking, logical thinking, perceptiveness and concentration. They improve cognitive processes and graphomotor skills as an introduction to writing. They extend knowledge, allow one to experience something new, stimulate cognitive interest, and activate the spatial imagination zone. Moreover, geometry-related activities shape Mathematical skills, create situations in which one can feel positive effects of his own actions, support shaping a positive image of one's own Self, and help overcome fears of problems and issues. Geometric intuition, correctly shaped in preschool, is a baseline for a more systematic

study of Mathematics, including geometry, in school. Therefore, as early as in preschool, one should arouse children's interest in the world of Mathematics, encourage children to undertake actions aiming at knowledge extension, and emotionally and intellectually prepare them for the study of Mathematics in school. As the preschool child construes concepts in his own mind independently, according to the principles of constructionism, we should:

- ensure that every child has an ability to manipulate objects of various sizes and colours but of similar shapes,
- help children focus on the shape itself, so that they can name it or describe it with a gesture, e.g. a child is introduced to triangles in triangular plates and then draws the shape of a triangle in the air and names it,
- make sure the child tries to reconstruct the recognised shape in the form of a picture or using a geo-plan independently, which will allow the child to focus on the shape's properties.

Unfortunately, the publishing market is lacking publications concerning geometric education in kindergarten. Some of the publications in the field of Mathematics in kindergarten include short chapters relating to Geometry, but they mainly pertain to topics closely associated with implementation of the pre-school education's core curriculum. An example of said publications includes the previously quoted books by Edyta Gruszczyk-Kolczyńska and Ewa Zielińska. However, there are no methodological studies devoted solely to the implementation of geometric education in kindergarten and extension of concepts recommended in the core curriculum. It is particularly harmful when looked at from the point of view of preschool children.

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WRITING VERSUS TYPING IN THE BIOLOGY CLASSROOM: A CASE STUDY IN SLOVENIA

Metka Kordigel Aberšek
University of Maribor, Slovenia
E-mail: Metka.Kordigel@um.si

Introduction

The act of writing is a complex cognitive process, relying on perceptual sensorimotor combinations (Mangen et. all, 2015). Writing is the process of externalizing the content of our thinking, what we know, what we think, what we feel … Writing always involves the skilful handling of mechanical/technical devices, and necessarily results in a visuographic representation: some kind of readable text in a form of letters or symbols (Mangen, Velay, 2010). The neuroscientific research points out writing is a process that requires the integration of visual, proprioceptive (haptics/kinaesthetic) and tactile information in order to be accomplished (Fogassi, Gallese, 2004). The acquisition of writing skills of previous generations involved a perceptual component, learning the shape of the letter, and a graphomotor component, learning the trajectory producing the letters shape (van Gallen, 1991) – the process, that is probably going to change with the Generation Z. We cannot oversee that more and more of the current writing is the writing with digital devices, weather a laptop, tablet or smart phone. Computers and keyboards are replacing the pen and paper and children are increasingly encouraged to type instead to write by hand. Replacing handwriting with typing is, according to the contemporary cognitive science, not only an act of adjusting writing curriculum to new, predominant technical devices. It will have, with high probability, implications to high-level cognitive processes of the Generation Z (Kiefer & Trumpp, 2012). The cognition namely does not take place only in our brain, but also in the perceptual and motor systems (Calvo & Gomila, 2008). According to the *Embodied Cognition Theory* the processes of perception (visual, audio, tactile), motor action and cognition are strongly and reciprocally connected (Gibbs, 2005; Shapiro, 2010). Embodied cognition is an active sensory, probing of humans' surrounding lifeworld. Learning and cognitive development are the processes, in which we develop representations by – hapticly – the interacting with the environment, by exploring our surrounding with all our sensory modalities. In other words: theoretical and empirical knowledge about the cognition and the brain point out the necessity of the acknowledgement that »the hands have a role to play in teaching and learning« (Goldin-Meadow, 2003). Not only in gestures and non-verbal communication, but also, and more specifically, in the haptics interaction with different technologies (Mangen, Velay, 2010).

With new technologies the role of hands of the new generation has changed. The generation clicks and scrolls with computer mice and tap keys on keyboards and screens, instead of putting pens or pencils on paper. This switch from pens and papers to mice, keyboards and screen entails according to Mangen and Velay (2010) major differences in the haptics of writing at several levels.

The research in the field of the interdependence of writing modality and cognitive achievement has been performed mainly with the focus on the performance on the morphological and lexical level. But also the impact of the performance on the semantic level has been investigated – on the sample of adults. The present research was designed with the motivation to explore the interdependence of writing modality and achievements on the semantic level – constructing and recording knowledge. It was performed on the sample of the younger population, since we noticed that majority of the existing research was performed on the sample of a (nearly) adult population. The following research questions were addressed:

1. Do students' create important different texts when they write down new constructed knowledge with the pen on the paper in comparison with the text, created in the typing modality?
2. How does the written text differ from the typed text? Are the differences equally notable on the quantitative as on the qualitative level?
3. Are the differences between written any typed text interdependent with level of the acquired basic computer skills?

According to the theoretical backgrounds and previous research we assumed quantitatively and qualitatively better results in the writing modality than in the typing modality.

Methodology of Research

A qualitative and quantitative research approach was adopted since the main objective of the research was rather exploratory, due of the lack of extensive data. A text analysis was undertaken according to categories defined in the focus of the research questions.

Participants and Context

Twenty six children, aged between 10 years and 9 months and 11 years and 9 months participated in our research. All children were students of the same class (5th grade of the compulsory school). This was important to guarantee the same educational context of the research: all children had the same computer education (performed from the same computer skills teacher). All students had the same number of hours spent on the computer devices, they used for typing their texts, and all children participated in the same biology research project and had the opportunity to construct the same amount of knowledge.

At the beginning of the research a pre-test of students' basic computer skills was performed. Students evaluated their basic computer skills. The survey was a list of 21 computer basic sub-skills and student's marked, whether they *know*, do *know, but sometimes need some help* of the teacher or they *do not know* yet. Afterwards, the computer skills teacher was asked to re-evaluate students' self-evaluation. According to these results, students were divided into 3 groups: good/modest/week computer basic skills.

Research Procedure

All 26 students, which participated in the biology project, were divided into groups, according to their choice. After being informed they are going to explore a plant STINGING NETTLE (lat. *Urtica dioica*) they were asked to use KWL scaffolding method to form a list *what do they already know* about the plant and the second list *what do they want to learn*. Afterward the groups began to collect the information and knowledge about the *Urtica dioica*. They used the school library, home libraries and the World Wide Web. Every day they shared new knowledge with the schoolmates in their group and together it was decided, whether the information was correct and important and how should it be recorded on the graphic organizer they formed together. After a week, each group presented their findings to all other groups.

Data Collection

The next day (after the short studying of their own graphic organizer) students were asked to write a *textbook chapter* for the students, who will attend biology class next year and will learn about *Urtica dioica*. With the textbook chapter, a text sample was defined: informational correctness, terminological accuracy and the structure of the text - *description of the plant.* (Students already knew the text sample from their mother tongue class and previous use of this text structure at the biology class).

After 24 hours students went to their computer classrooms and again studied their graphic organizers. After that they turned on their computers and wrote the biology textbook chapter about *Urtica dioica* again. After finishing it each student saved and printed his text and marked it with a special (self invented) code, the same one he had used for coding his written text and his computer basic evaluation sheet.

Data Analysis

Both texts were evaluated according to its‘ motphological, syntactic, and semantic elements. Data from a written text of each student was compared with the data of his typed text, and all results were observed and evaluated from the perspective of the students’ computer basic skills.

Results of Research

The gained results only partly confirmed the expected results. More precisely: the results on the quantitative level showed a different picture as expected. The writing modality seems to have no influence on the number of used words, the number of different used words and on the number of sentences. On the contrary, some students wrote more words and more sentences in the typing modality. Differently the typing modality seems to have an influence on the cognitive achievement. Syntactic structure of the written text shows in comparison with the typed text more an advanced structure. In addition, on the semantic level more knowledge and deeper understanding of the knowledge was detected in the written text than in the typed text. Finally, as we assumed, we found a stronger influence of writing modality on the quantity and quality of the text among the students with lower level basic computer skills.

Conclusions

The results of our research confirm the expectations of the theoretical background (embodied cognition) and the expectations of the previous research of interconnection between writing modality and cognitive achievement. All that despite the fact that the Generation Z evidently uses the keyboard with a greater ease than the pencil and despite the fact that they are able to type a greater number of words in the same time frame as they are able to write them with the pencil. A closer look to their text-product shows a different picture: in the typing modality, they seem to be cognitively overloaded. In addition, the consequence of that is a lower level of academic achievements in their typed text. They show les knowledge, less terminological accuracy - and above all - less understanding of the interconnection between the listed information.

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MOTIVATION AND ATTITUDES OF MEDICAL STUDENTS TOWARDS TEACHING AND LEARNING NATURAL SCIENCES

Eva Kralova
Comenius University, Slovakia
E-mail: eva.kralova@fmed.uniba.sk

Abstract

Attitudes of medical students towards *teaching and learning of natural sciences as an inevitable part of medical curriculum are often negative and lack of motivation is observed. Research project is focused on the identification and subsequently application of motivating approaches in the teaching. Pedagogical investigation using anonymous questionnaire was used with the aim to specify respondents (1st year students of Comenius University Faculty of Medicine in Bratislava) motivation and attitudes towards teaching and learning natural sciences before starting medicine study and after 1st semester of medicine study.*
Keywords: *university medical education, students' motivation, natural sciences*.

Introduction

Medical study and practice put high demands on analytic and synthetic thinking of students and health professionals. These requirements could be developed during university study of natural sciences. Natural sciences (medical biophysics, medical chemistry, medical biology) are usually included in the group of theoretical disciplines and they are taught at the beginning of medical study (VFME, 2003). Attitudes of medical students after graduation at general secondary schools regarding the study of natural sciences as an inevitable part of medical curriculum are often negative (Balazsiova, 2014). Therefore, it is necessary to find motivating approaches and strategies in teaching process and try to change these negative attitudes in a positive way by improving motivation of medical students towards learning the natural sciences.
The research project "Motivating factors of medical students for better understanding the fundamental science knowledge in relation to medical diagnostic and therapeutic methods" is focused on the identification and subsequently creation of motivating teaching of the natural sciences (Kralova, 2016).

Methodology of Research

The results of the pedagogical investigation using anonymous questionnaire at the end of the first semester of medical study acad. year 2016/2017 are presented (131 respondents – 1st year students of Comenius University Faculty of Medicine in Bratisla-

va, 38 males and 93 females) focused on previous and current attitudes and level of their motivation concerning natural sciences (medical biophysics, medical chemistry, biology and human genetics). Respondents rated their attitudes on the scale from 0 (negative) to 10 (positive). All obtained data of questionnaire were saved in the electronic database in the MS Excel, statistically evaluated and graphically represented using basic tools available in the MS Excel. Attitudes of respondents and level of their motivation to study natural sciences were categorized into five categories (negative, slightly negative, negative, slightly positive and positive), expressed in percentage and analysed in dependence on age, sex, demographic factors and type of completed secondary school.

Results of Research

The analysis of our survey showed motivation of respondents to study medicine. The main motivating factors were identified: aspiration to become a doctor (17.2%), help people (17.1%), interest in the medicine (16.9%), scientific research (14.7%).

Attitudes of respondents to the natural sciences after graduation at general secondary schools (physics, chemistry, biology) were negative and slightly negative – 45%, 6.3%, 0%; neutral – 28.5%, 20.5%, 16%; slightly positive – 17.6%, 59.8%, 67.2%, positive – 3.8%, 13.4%, 16.8%, respectively.

Attitudes of respondents to the natural sciences (medical biophysics, medical chemistry, medical biology) in the 1st year of medical study as an inevitable part of medical curriculum were negative and slightly negative – 22.2%, 6.0%, 3%; neutral – 51.9%, 39%, 30.5%; slightly positive – 22.1%, 47%, 55.0%, positive – 3.8%, 8.0%, 11.5%, respectively.

The lowest level of motivation to study medical biophysics, the higher motivation to study medical chemistry and medical biology (negative and slightly negative – 26.0%, 4.0%, 4.6%; neutral – 48.1%, 35.4%, 34.3%; slightly positive – 22.1%, 50.5%, 50.4%, positive – 3.8%, 10.1%, 10.7%, respectively) were found at the end of 1st semester of medical study.

What main motivating and demotivating factors in the teaching and learning of the natural sciences have been formulated by respondents?

1. Motivating factors: positive approach and professionalism of teacher (28.4%) and better continuity with medical practice (13.2%).
2. Demotivating factors: both lack of continuity with medical practice and big time and content demands (31.5%).

Conclusions and Implications

Teaching and learning of the natural sciences at medical faculties should support the improvement of educational level. It is required to optimize them and thus to improve quality of education and international competitiveness of graduates. The most difficult situation in the teaching of physics and medical biophysics was indicated. Most often attitudes and motivation of the medical students to physics and medical biophysics are negative and very negative. The role of the teacher is to overcome these barriers in the educational process. The fulfilment of this goal requires to increase students' motivation, communication of university teachers of the natural sciences with both clinicians and

medical students and to provide further training of university teachers in the university pedagogy (Black, Howard-Jones, 2000). It is also necessary to find motivating approaches and strategies in teaching process of the natural sciences and apply them to improve motivation of medical students.

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SCIENTIFIC RESEARCH ACTIVITY OF STUDENTS PRE-SERVICE TEACHERS AT UNIVERSITY: COMPARATIVE ANALYSIS OF UNDERSTANDING, INTEREST AND CAREER ASPECTS

Vincentas Lamanauskas, Dalia Augienė
Šiauliai University, Lithuania
E-mail: v.lamanauskas@ef.su.lt, augiene@gmail.com

Abstract

Scientific research activity (SRA) is a constituent part of university studies. It is very important that this activity was consequently developed, and that the students acquired necessary research activity competencies. On the other hand, scientific research activity realises the essential teacher preparation paradigm direction – towards research based teacher education.
On the basis of two qualitative research, a comparative analysis was carried out, seeking to analyse how differ positions of two study field students, pre-service teachers in respect of scientific research activity. In the research participated 84 pre-service teachers of natural sciences and 90 pre-service teachers of social sciences. The research was carried out between February and March, 2016.
Research results show, that these two group students' position in respect of SRA significantly differs.
Keywords: *comparative analysis, science education, scientific research activity, university students*.

Introduction

Scientific research activity (SRA) and pre-service specialist professional qualification/ competence are directly related subjects. In SRA scientific literacy forms, scientific culture is developed, research method application abilities and other abilities necessary for such an activity are formed. All this constitutes pre-service teacher-researcher competence.

Today, in knowledge society, research abilities become the main abilities, owing to which fundamental and applicable type of knowledge is obtained. Therefore, today every society raises new education purposes, seeks to reconstruct its education system so, that it could control innovations influenced by globalisation and prepare the young generation to live in a globalised world and act in a competition based market economy. World practice shows, that studies at university are based on science, by them it is sought to prepare an educated man, corresponding to modern world needs. Universities are not oriented only to concrete specialist preparation. In a wide context, university scientific activity is very important, its level and society and economy need

compatibility, contribution to society and state development, educated, insightful people preparation to work actively. In modern world a very important becomes ability not only to master knowledge, but also to make something your own and participate in society and world change. Especially accentuated is young people's interest in science: research, achievements, new possibilities. In order to cognize modern world and to make competitive decisions, one needs scientific knowledge and ability to control scientific world cognition method, scientific knowledge creation. Therefore, more attention at universities is devoted to students' scientific research work skill formation, creative thinking, creativity and productive self-expression development.

Thus, it is obvious, that for the teacher in education practice it is important to be able to apply scientific research approaches and technologies analysing, reflecting the education itself, evaluating effectiveness, improving education process and so on. On the other hand, it is important, that the teacher was able to form students' scientific research work abilities, encouraged them to cognize, evoked their curiosity and interest.

Speaking about university studies it is important to accentuate, that scientific research activity includes not only compulsory part of the studies (content is foreseen in the study programmes), but also the other activity (projects, scientific practices and so on) beyond the compulsory study process boundaries. On the other hand, study programmes are different, marking themselves in specificity and so on. For example, speaking about pre-service teachers of natural sciences and technologies one can claim, that both a type of the programme, and their specific character are favourable for the realisation of scientific research activity and for the research competence development. Whilst, pre-service teachers of social sciences are much weaker oriented towards scientific research activity, their abilities in this field are poorly formed. However, as researchers assert, to provide good quality higher education to the next generation, government and universities should work together to address disparities and fill gaps in the research-teaching nexus (Karagiannis, 2009). Equally, without the capabilities to test new pedagogical approaches and understand their impact on learning, teachers have no way to determine the effectiveness of their strategies (Bower, 2010). Close links between research carried out at university and study process are also very important. Researchers discern various models of such links (Griffith, 2004). The carried out research show, that research-based academic studies allow students developing research-related capabilities by promoting critical scientific thinking, solution of problems and use other analytic strategies and technical tools (Fernate, Surikova, Kalnina, Romero, 2010).

Thus, the aim of the analysis is to compare two student group – pre-service natural science and social science teachers' – positions on the question of scientific research activity at university. It is likely, that there exist significant scientific research activity understanding, interest in this activity, importance to teacher profession perception, differences. One can also think, that these group student attitude to scientific activity and to teacher-researcher career in future also significantly differs.

Research Methodology

A qualitative, pilot – explanatory type of research was carried out. The research was carried out between January and February 2016, i.e. at the beginning of the second term of studies. In the research participated 174 students, pre-service teachers from three

Lithuanian universities. 84 respondents represented the field of natural sciences, 90 – the students from the field of social sciences.

For the formation of sample, non - probability purposive research group formation method was chosen, when the people included into a research group are the most typical in respect to the researched quality. Referring to Morse (1994), the sample of 30-50 participants is suitable for such kind of research.

Research data were expressed in writing. The qualitative research data were processed using content analysis, when in the informative array essential characteristics are distinguished. The data of both respondent groups were analysed and presented separately (Lamanauskas, Augienė, 2016a, 2016b; Lamanauskas, Augienė, 2017).

Comparative analysis of two respondent groups was carried out according to 4 main variables: SRA understanding, interest in SRA, importance to teacher profession, attitude to researcher career. Fisher φ multifunctional criterion is used to ascertain the expected differences, which is sufficiently universal and comfortable to use. It can be applied without taking into consideration, whether the sample is related or not (Sidorenko, 2002). Making a statistical decision, not the respondents' number is considered a sample, but an array of semantic categories, distinguished during content analysis.

Research Results

Having analysed the respondents' expressed opinions about student scientific activity at university, certain differences were distinguished (Table 1).

Table 1. The understanding of student scientific research activity at university.

Pre-service teachers of sciences			Pre-service teachers of social sciences			φ_{emp}; p
Categories	*N*	*%*	*Categories*	*N*	*%*	
Active work	40	51.4	Active work	42	36.2	2.09; .018
Compulsory study component	24	30.6	Compulsory study component	60	52.7	3.08; .001
Professional improvement	14	18.0	Professional improvement	11	11.1	1.33; .092
Total*	78	100	Total*	113	100	

Note: The total means the number of semantic answers distinguished

More than half (51.4%) pre-service teachers of sciences understand student scientific research activity as *Active work,* which is most frequently identified as students' independently and together with teachers performed research, studying of scientific sources and participation in scientific events i.e. in students' understanding are reflected all scientific research activity stages what scientific research activity at university is. The obtained results allow asserting, that the majority of pre-service teachers of sciences understand student scientific research activity as partly independent student activity, and not only as a constituent part of the studies. Only a third part (30.6%) of pre-service teachers of sciences understand scientific research activity as *Compulsory study component*, i.e. as a constituent part of the studies. Whilst the majority of pre-service teachers of social sciences (52.7%) understand student scientific research activity as

Compulsory study component, which they identify with study task performance, course paper and final work preparation. A smaller part of pre-service teachers of social sciences (36.2%) – understand student scientific research activity as *Active work.* A hypothetic assumption can be made, that this difference is determined by study programme (natural science and social science study subjects) and natural science research specificity. As one can see from Table 1, differences according to the first two categories are statistically significant.

The smallest part of pre-service teachers of sciences (18.0%) and pre-service teachers of social sciences (11.1%) understand scientific research activity as *Professional improvement*.

Having analysed the respondents' expressed opinions about students' interest in scientific research activity at university, certain similarities and differences were distinguished, defining the latter interest in such an activity (Table 2).

Table 2. Students' interest in scientific research activity.

Pre-service teachers of sciences			Pre-service teachers of social sciences			φ_{emp}; p
Categories	*N*	*%*	*Categories*	*N*	*%*	
Obligatory /pragmatic interest	43	57.3	Obligatory /pragmatic interest	50	44.5	1.70; .045
Personal/ internal interest	22	29.4	Personal/ internal interest	34	30.8	0.21; >.05
Lack of interest in scientific research activity	10	13.3	Lack of interest in scientific research activity	26	24.7	1.95; .025
Total*	75	100	Total*	110	100	

Note: The total means the number of semantic answers distinguished

The greater part of pre-service teachers of sciences (57.3%) and pre-service teachers of social sciences (44.5%) are interested in scientific research activity only because it is an obligatory activity, presented tasks in the study process, final works and so on require this. (Obligatory /pragmatic interest). A third of the students (pre-service teachers of sciences (29.4%) and pre-service teachers of social sciences (30.8%)) to be interested in scientific research activity at university encourages *Personal/ internal interest.* Students think, that this is an interesting, perspective activity. A part of the students are not interested in scientific research activity, because it is uninteresting, complicated and so on. Here, the biggest differences were revealed between both respondent groups. Mostly not interested in scientific research activity are pre-service teachers of social sciences - 24.7%, and there are significantly less of pre-service teachers of sciences - 13.3%. The latter difference is statistically significant (p=.025).

Having analysed the respondents' position about scientific research activity significance to teacher profession, certain similarities and differences were distinguished (Table 3).

Table 3. Scientific research activity significance to teacher profession.

Pre-service teachers of sciences			Pre-service teachers of social sciences			φ_{emp}; p
Categories	*N*	*%*	*Categories*	*N*	*%*	
Professional improvement	56	66.8	Professional improvement	95	86.4	3.26; <.001
Personality improvement	26	30.8	Personality improvement	15	13.6	2.91; <.001
Minimal significance	2	2.4	-	-	-	
Total*	84	100	Total*	110	100	

Note: The total means the number of semantic answers distinguished

The research revealed, that both respondent groups relate scientific research activity significance to teacher profession first of all with professional improvement. In students' opinion, owing to scientific research activity, teachers develop their competencies, learn to perform applicable research, accumulate experience, better know their students. However, there are more pre-service teachers of social sciences (86.4%) thinking like this than pre-service teachers of sciences (66.8%). This difference is statistically significant when p <.001. Students also accentuate scientific research activity importance to teacher personality improvement. Thinking like this are more of pre-service teachers of sciences (30.8%) than pre-service teachers of social sciences (13.6%). This difference is also statistically significant (p <.001).

Pre-service teachers' expectations, i.e. intention / wish to relate their professional activity in future with scientific research work also determine positive attitude to scientific research activity (Table 4).

Table 4. Intention to do researcher (scientist) work (career) in future.

Pre-service teachers of sciences			Pre-service teachers of social sciences			φ_{emp}; p
Categories	*N*	*%*	*Categories*	*N*	*%*	
Positive attitude	38	50.7	Positive attitude	16	18.2	4.47; <.001
Negative attitude	37	49.3	Negative attitude	72	81.8	4.47; <.001
Total*	75	100	Total*	88	100	

Note: The total means the number of semantic answers distinguished

Obvious differences were revealed between both groups. Half of pre-service teachers of sciences (50.7%) and only18.2% of pre-service teachers of social sciences value researcher (scientist) career positively. Difference is statistically significant (<.001). 49.3% of pre-service teachers of sciences value researcher (scientist) career negatively

and even 81.8% of pre-service teachers of social sciences. This difference is also statistically significant (<.001). The greater part of respondents claim, that they wouldn't like researcher (scientist) career, because researcher (scientist) career is uninteresting, requiring a lot of expenditure. A part of students think, that they have no suitable personal qualities for that activity. The obtained results allow making a hypothetical assumption, that modern students are not interested in scientist career, because scientist activity is valued worse and worse in society. Very often young people are prone to seek quick results in professional activity.

Conclusions

The greater part of pre-service teachers of sciences understand student scientific research activity as *Active work*, and the greater part of pre-service teachers of social sciences understand student scientific research activity at university as *Compulsory study component*.

The majority of pre-service teachers of sciences and pre-service teachers of social sciences are interested in scientific research activity only because, it is a compulsory study process part (Obligatory /pragmatic interest). A third of students pre-service teachers of sciences and pre-service teachers of social sciences to be interested in scientific research activity at university encourages *Personal/ internal interest.*

The research revealed, that both respondent groups relate scientific research activity importance to teacher profession first of all with professional improvement. A third of pre-service teachers of sciences accentuate scientific research activity importance to teacher personality improvement.

The research revealed, that half of pre-service teachers of sciences value researcher (scientist) career positively, half – negatively. Most of pre-service teachers of social sciences value researcher (scientist) career negatively and do not plan to seek such career in future.

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THE INFLUENCE OF CHEMICAL LANGUAGE IN THE REWORKING OF BASIC CONCEPTS IN ELECTROCHEMISTRY

Solange W. Locatelli, Paulo H. Gomes
Federal University of ABC, Santo Andre, Brazil
E-mail: sol.locatelli@gmail.com

Agnaldo Arroio
University of Sao Paulo, Sao Paulo, Brazil
E-mail: agnaldoarroio@yahoo.com

Abstract

Understanding the submicro level is difficult for students, requiring a deeper chemistry knowledge. In this study, 32 students performed a teaching-learning sequence in order to understand the submicro level of two electrochemical reactions. Among the thirty-two students, eight of them were analyzed, using the records and the transcriptions of the filming. The results indicated that students who used more chemical terms were able to achieve better understandings of the submicro level, since that talking more, in this case, showed no relation to learning.
Keywords: *electrochemistry, chemical education, chemical terms, representational level, submicro level.*

Introduction

Comprehending chemistry involves three representational levels - macro, symbolic and submicro (Johnstone, 1993) being the latter the focus of this work. Cheng and Gilbert (2009) argue that an obstacle to learning chemistry may be related to the difficulty in transiting between the three levels. Treagust, Chittleborough and Mamiala (2003) argue that for better mastery of chemistry concepts, it is necessary to encompass representations at the symbolic and submicro levels. These researchers refer to two levels of understanding, whose difference is in depth, namely instrumental and relational. The instrumental level refers to mechanical learning (Skemp, 1976), which according to Cheng and Gilbert (2009), students do not respond to questions that demand deep knowledge. Already at the relational level, the students demonstrate the reason why he or she is doing something (Skemp, 1976). The purpose of this paper was to understand the difference in the trajectory of 4 groups (8 students out of a total sample of 32) when performing a chemistry activity. Half of them managed to demonstrate a transition from the symbolic to the submicro level (transition group) and the other half of them did not succeed in this (no transition group). The question is whether this could be due to the quality in the discussion that could lead them to good results. Therefore, the research

question is: *During the groups discussion, how does talking more or using more chemical terms help in the construction and reconstruction of ideas?*

Methodology of Research

Eight students aged 16 to 17 enrolled in a private high school in Sao Paulo (Brazil) participated in the study. An audio recording was made in which they were performing a teaching-learning sequence referring to basic concepts in electrochemistry. The task was to propose explanations for the submicro level of chemical reactions between solid iron and copper and hydrogen ions. Transcriptions of these discussions were made in order to verify how the quantity (speaking more) or the words quality (chemical terms) interferes to achieve good results. For the counting of the words and the chemical terms during the discussion, 2 parts (of 11) were selected, which correspond to the parts of the construction and reconstruction of the submicro level. From the Microsoft Word software's option, "counting number of words" the quantity of words from such passages was determined. For the quantification of the chemical terms, Guedes's (1992) proposal was used, selecting the categories 1, 2 and 4 of his work, respectively related to chemical terms:

- Category 1: structural - for example: atom or electron.
- Category 2: specific – for example: iron or copper ion.
- Category 4: group of constituents - for example, sulphate or acid.

These three categories were chosen, since they constituted a specific language in Chemistry. The analysis carried out with the category proposed by Guedes (1992) was validated by three components of distinct research groups that did not participate in this work. Subsequently, a comparison was made between transition and no transition groups searching for similarities and differences regarding the quantity of speech and the amount of chemical terms.

Results of Research

Figure 1 shows the results for the quantities verified:

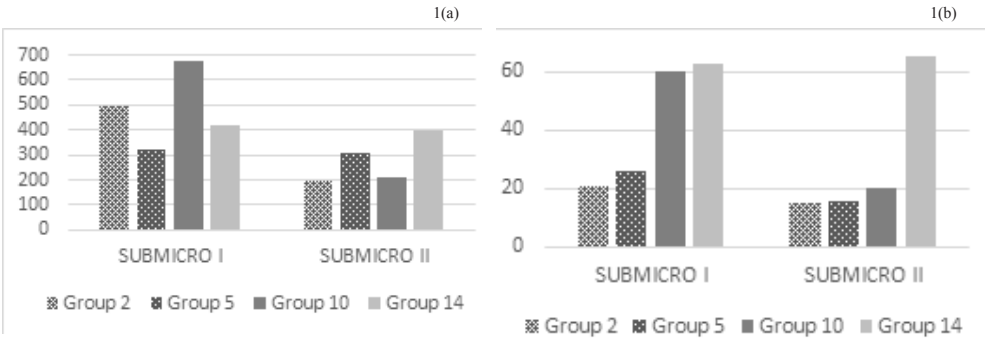

Figure 1: (a) Number of words in the groups (b) Amount of chemical terms in the groups.

Figure 1 (a) seems to denote no relationship between a larger number of words and better performance. For example, group 2 spoke more than group 14 in submicro level I, but did not obtain a better result. This indicates that just talking more will not necessarily lead to good results. In general, the analysis of figure 1 (b) allows us to infer that the transition groups (10 and 14) used a greater amount of chemical terms to elaborate and re-elaborate explanatory models in the submicro level than no transition group (2 and 5). This may be an indication of a relational understanding regarding to chemical reactions, going deeper into the discussions. The explanatory model of the submicro level requires an abstract and therefore difficult thinking from the students (Al-Balushi, 2013) with an accurate chemical language. Thus, the more precise use of this language (chemical terms) becomes fundamental to the achievement of good results, which may explain, in part, the advancement of these two transition groups.

Conclusions and Implications

The results of this research point out that for the construction and reconstruction of chemistry concepts related to the submicro level to occur, a discussion among the students using chemical terms becomes necessary. This is due to the fact that the submicro level is very abstract and uses a very specific chemical language, and then in order to be able to transit in it, it is necessary to use this language fluently. Discussing more (speaking more) does not necessarily lead to good results precisely for the reasons given. Other factors are possibly involved in these reconstructions, but herein it is pointed out that in this case, it was possible to verify that qualified use of chemical terms may have been a factor for the students to achieve good results. Further studies are suggested that seek to establish relationships between the chemical language used by the students and the results obtained, which may lead to better learning in the Chemistry area.

Acknowledgements

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NATURAL SCIENCE LESSONS: PRE-SERVICE PRIMARY TEACHERS' EXPERIENCE

Rita Makarskaitė-Petkevičienė
Lithuanian University of Educational Sciences, Lithuania
E-mail: rita.makarskaite@leu.lt

Abstract

"Science Education in Europe: National Policies, Practices and Research (2011) discusses students' natural science literacy, generalises international research results, names natural science education problems, searches for solutions. One of them – suitable teacher preparation. This article analyses what experience pre-service primary teachers have about natural science lessons and what, in their opinion, is necessary for the students to like natural sciences.
Keywords: *personal experience, pre-service primary teachers, opinion research, lessons in nature.*

Introduction

In "Science Education in Europe: National Policies, Practices and Research" published by European commission (2011), students' natural science literacy is discussed, PISA and TIMSS research results are generalised, natural science education problems are identified, solutions are searched. A lot of attention in this publication is paid to teacher preparation. It is not easy to become a good natural science teacher, because natural sciences have distinctive features, for example, specific epistemology – knowledge acquisition way, which is often identified as "Nature of Science; NOS" and practical work application. The research are presented in this publication (Seung, Bryan and Butler, 2009; Lotter, Singer and Godley, 2009; Abd-El-Khalick and Akerson, 2009), which confirm, that having tried to increase teachers' experience in the field of NOS, good results were obtained. Having applied metacognitive strategies, for example, conception maps, colleague ideas about NOS and case research in this sphere, pre-service primary teachers' natural science knowledge has increased. By another research it was established, that natural science teachers, whose subject knowledge is poor, tend to avoid certain topics or rely on the textbook too much and give easier questions (Van Driel ir Abell, 2010). Melville and other (2008) proved, that teachers' ability to teach to perform different research depends on their own possessed experience in this field and the ability to foresee possible challenges, conducting research during the lessons.

Learning basis of today's natural sciences is - experiments, tests and research. While researching the children develop natural science understanding, quicker and deeper master new information. Charlesworth & Lind (2013) notice, that children, researching real world are full of enthusiasm, and real activity is worth more than a thousand photos. R. A. Duschl, H. A. Schweingruber and W. A. Shouse (2007) agree with this, saying, that students understand natural sciences best being involved in practical natural

science activity. Actively working they develop research abilities: to raise a hypothesis, research aim, to fix the results, and to generalise them, to make conclusions, to identify reasons and consequences. Therefore, preparing primary teachers it is necessary not only to provide them with sufficient amount of natural science knowledge, but to develop abilities to organise natural science activity and to conduct research. Every student from the schooldays has accumulated certain experience about natural science lesson. This experience preparing to be a teacher can be useful, if only it is considered and related with professional expectations.

Research aim is to analyse pre-service primary teachers' experience about natural science lesson in primary school.

Methodology of Research

Research Characteristics

The research was carried out in April, 2017. It is grounded on the attitude that pre-service teachers' opinion research is an effective means not only modelling natural science didactics content in a higher school, but also seeking natural science education quality in a primary school.

Instrument

Five open question - answer sheet was used in the research. The respondents were given these questions:

- Remember please, any natural science lesson from the schooldays. What was it? What was particular about it, if you remembered it?
- What do you think, why students like natural sciences?
- Please share your thoughts, why students do not like natural sciences?
- What experience about learning in nature have you brought from school?
- How should primary school students be taught, to get interested in natural sciences?

Research Sample

In the research participated 15 pre-service primary teachers (II- course), who had taken part in the lecture. This makes 75 % of all course students.

Results of Research

Having analysed students' answers to the first question, (What natural science lesson do you remember? What was particular about it, if you remembered it?), it has been stated, that for a part of students (N-4) an analogical activity, performed at university during nature didactic activities helped to remember such lessons: *Onion planting, growth process observation. Remembered, because recently we did it at university as well; Planted beans and grew them up on the windowsills. Every day we fixed, how much they grew up. We also wanted to make it clear recently, what it is necessary for*

the plant to grow; we were looking for blooming plants in the school yard. I was looking for blooming plants and their pollinizers with the course friends during spring tour in nature; we watched them through a microscope. The lesson was interesting, unusual. Practical work in microscopy helped to remember this lesson.

The other students (N-3) remember the lesson, because it was outside, not in class: *During biology lesson we went to gather tree leaves. This lesson was different: free, active, joyful; it was warm. The lesson was outside. We gathered tree leaves, bush fruits; in spring we hung bird houses in the park, which we had made ourselves.* These students not only mention natural educational environment, but also active work in it, accentuate the importance of their work.

A smaller part of respondents (N-2) remembered natural science lesson because of visualisation, clear content or suitable education process organisation methods: *A lesson about human bones... The teacher showed every small bone on a human skeleton. Only then I understood, what is where; it was interesting for us. We researched a lot. Everything used to be clear, understandable, and the science itself seemed easy and interesting.*

For the same part of respondents (N-2) the lesson was memorable, because their as students' interests were satisfied: *From primary classes I remember the lessons with Kaukutis best. This is a dramatic character. I liked to colour his tasks; Planting of flowers in the field. I remembered this lesson, because I liked to plant the plants. I like it up to now*. There were respondents (N-2), who identified teacher's role (*I remember natural science lessons not because that we went somewhere, but because of the teacher. She was able to convey the material in such a way that it seemed, that biology was the most interesting subject)* and the new activity experienced in the lesson (*We researched plant texture under the microscope. It was interesting, because we did it for the first time).*

The remaining two students couldn't name any memorable natural science lesson.

One can see, that the memories of a third of students reach primary school days (7-11 years), and not nature lessons in senior forms. The respondents, talking about school lessons, do not mention chemistry and physics lessons at all.

The second course students – have been schoolchildren recently, therefore they look to many things from schoolchildren's positions. Therefore, by two other questions it was sought to ascertain, what particular is about natural sciences that students like them and do not like.

Two thirds of respondents (N-10) identify research works as the most important thing attracting students: *One can do a lot of experiments, learn through experience*; *One can perform research and understand the surrounding environment, one can learn from experience; ... because we are researching, talking about interesting things; Nature is around us, students like researching objects, that surround us*; *One can research a lot, observe nature, environment; Tests are done frequently, research are done; One can investigate, be a little scientist; A lot of discoveries: find out something new, research, do laboratory tests; Environment research are related with a man. This is actual; ...natural science is not dry. You can cram theory, but can find it while researching.*

Analysing these students' thoughts, a few more important moments are revealed: personal experience, an experience, and discoveries. These are research based learning results.

The other respondents (N-3), speaking about the attractiveness of natural sciences, distinguish nature subject content actuality for the learner: *A man has to be interested and to know the environment, in which he lives; it is actual for the students. They solve ecological problems. Besides, almost every student's free time is related with nature... information is actual for students, which they can apply everywhere.*

The remaining part of respondents (N-2) identify a possibility to learn in the other surrounding than class: *Learning in the fresh air is always more fun; Learning in nature is as if relaxation. And if students have a creative teacher, nature lessons are very interesting.*

The other question is why students do not like natural sciences. It has been stated, that a third of respondents (N-5) acknowledge, that natural science subjects are complicated and requiring responsible work. For example: *...there are a lot of complicated topics; natural sciences have very broad spectrum and students get too much information; Sometimes there are complicated things, at which one needs to stop, think over; Basically, it is quite a complicated science; Some topics can be complicated and not understandable for students.*

The same part of respondents (N-5) notice, that teachers work not in the way they should to: *...very often they limit themselves to theory; ...the content of the subject is not presented in an interesting way; Sometimes teachers' presentation is very boring; Usually learning takes place in class from textbooks, but not in nature; Not all teachers are able to properly convey information, to make students interested, to give such tasks, which made them interested.*

The rest of the respondents (N-4) identify very different factors: uninteresting content (*not for all children is interesting about worms, frogs and so on.*); unimportant subject *(teachers and parents devalue these lessons, because they consider languages and mathematics to be more important subjects);* fear of being in nature *(a lot of ticks in nature, other poisonous creatures, therefore students have an attitude formed beforehand, which they bring from home);* tiredness *(students are not accustomed to travel, therefore they get tired during tours in nature).* One respondent did not answer this question.

Respondents were asked, what experience about learning in nature they brought from school. It was revealed, that more than half of the respondents (N-8) haven't got experience of learning in nature (*My experience is zero; I didn't have lessons in nature; My teachers didn't arrange such lessons; I don't remember lessons in nature; I didn't have an opportunity to learn in nature; Any).*

Part of the respondents (N-5) acknowledged, that sometimes they learnt in nature (*Lessons in nature were rarely, therefore there is not much experience; my experience is sufficiently poor. Only a few lessons in nature, but I still remember; we learnt in nature rarely. During 12 school years we learnt in nature probably 5 times, though school was near the forest; We used to have only physical education lessons outside or we went outside, when we had to tidy the environment; Small experience. Very little was going in nature*).

Two students (N-2) often had lessons in nature *(Not only nature, but also physical education, art, English lessons were in nature; ...to learn in nature through experience. I am glad, that I was taught in this way).*

Pre-service teachers were asked, how primary class children should be taught to get interested in natural sciences. More than a third of students (N-6) understand the specifics of the subject and they suggest paying bigger attention to specific methods (research, experiments) and for learning they suggest using real natural environment. For example: *Let the students research and experience, arrange tours, do experiments, perform a lot of practical works; One has to provide students with more possibilities to experiment and organise lessons in nature; I think, that it would be very good for students to learn through experience, that they do tests themselves, research in nature; Together with students to do experiments, to research nature objects; Practical activity should prevail in nature lessons; One should allow students to feel researchers.*

The other respondents (N-2) doubted in purposefulness of textbooks and exercise books in the lesson (*In our schools still prevails work with the textbook. Paying so much attention to the textbook, lesson time is lost, which could be allotted for research; to teach not only according to the textbook. Not to try to finish it, but always search for something new*).

A similar part of respondents (N-3) see a way out in subject integration and learning in real, i.e. natural environment (*Integrate with other subjects, be more outside; Organise integrated days in nature. During these days one activity would change another. Both languages, and mathematics, and technologies would serve to nature research; Nature cognition can be that integrating subject, if only we pay more attention to it).*

The other respondent opinions separated. They accentuate separate things. Some of them (N-2) suggest searching virtual and real (natural) environment harmony (*For today's child technologies are interesting. One has to use them, teaching natural sciences; It is dangerous to learn only in virtual space, one has also to learn in nature).* The others (N-2) doubted, if world cognition content is not too easy in primary school *(...one has to show students the access to a deeper and more purposeful natural science content*), if the same tasks suit for boys and girls *(more suitable tasks are necessary for boys, in order they learn equally well as girls*).

Conclusions

The research showed, that the respondents understand natural science specificity. They understand, that it will be difficult for students to start liking natural sciences, if they learn in class, only from textbooks, ignoring research and learning in real, natural environment. Students value, what is acquired through experience and active work.

Future primary teachers perceive natural science education complexity, value teacher efforts to organise natural science education process so, that students experience a joy of discovery and do not experience learning difficulties.

Creating one's own typage of a teacher, it is important to return future teachers back to school years to recall and reflect on some education aspects of that time and to evaluate them in today's education understanding context. Looking ahead, pre-service primary teachers, seeking natural science education quality, would search for subject integration, would seek virtual and natural learning environment harmony in education process, would pay attention that education content corresponds to learners' demands and interests.

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INCREASING YOUTH'S ECOLOGICAL AWARENESS OF AIR POLLUTION WITH THE USE OF NEW MEDIA

Anna Michniewska, Karolina Czerwiec, Katarzyna Potyrała, Renata Staśko, Emanuel Studnicki
Pedagogical University of Cracow, Poland
E-mail: anna.michniewska@gmail.com, karolinaczerwiec@gmail.com, potyrala2@wp.pl

Abstract

Ecological awareness involves natural knowledge, subjective perceptions, emotional commitment, and personal activity. It is shaped in a complex process under the influence of generally accepted social norms, information from mass media, formal and informal education. Increasingly young people are using new, new media to raise awareness. Research is concerned at the use of mobile applications in natural sciences on the example of air pollution. The aim of the research was to test the effectiveness and attractiveness of mobile applications devoted to the problem of air pollution among youth. Research has conducted focus interviews with middle school students on the use of applications in natural science lessons, and analyzed mobile applications and websites on air pollution.
Keywords: *environmental awareness, high school students, mobile applications, new media*.

Introduction

Ecological awareness is a part of the social awareness of information and beliefs about the natural environment, and the perception of the relationship between the state and nature of the environment and the conditions and quality of life of people, especially in the field of ecological hazards (Papuziński, 2005; Selvam & Abdul Nazar, 2011; Hadzigeorgiou & Skoumio, 2013). A study carried out in 2014 by the Ministry of the Environment on the awareness and ecological behavior of Polish residents shows that air pollution is one of the biggest problems in our environment (Research Report, 2014).

In addition, research indicates that the topic of air quality and its pollution is not sufficiently known to the public. The results of the Eurobarometer show that only one in three Poles (32%) are well informed on issues related to air quality (Attitudes of Europeans to air quality, 2013). The ecological awareness of children and young people is shaped mainly in school by acquiring knowledge, skills and attitudes in natural science classes (Kowalski, 2014), and in recent years also through social campaigns such as the Health and Breath Campaign, held in 2015 and 2016 in Cracow.

Ecological awareness training can take place in 4 stages (Żeber-Dzikowska, 2016):

1. Awareness (awareness of environmental issues)
2. Interest (gathering knowledge)

3. Will (determination of actions)
4. Action (pro-ecological actions).

Increasing ecological awareness can take place with the use of new media, which gives the opportunity to influence selected social groups in particular youth. In the age of globalization in many areas of social, political, economic and cultural life, the Internet is playing an increasingly important role. The social changes that have taken place over recent years, in particular the need for lifelong learning, justify the need to develop new learning methods regardless of age, place of origin or stage of education. Thanks to advances in technology, people everywhere in the world can use educational portals, e-learning courses, as well as educational applications.

The number of air pollution applications that can be used by students and teachers is really large and increases over time. Also available applications are constantly updated and adapted to the needs and expectations of users. Among the applications that can be successfully used in education as well as on a daily basis may be, for example, mobile application of Air Pollution.

Methodology of Research

The aim of research was to test the effectiveness and attractiveness of mobile applications devoted to air pollution among secondary school students.

Pilot studies conducted in 2017 analyzed the available mobile applications and websites on air pollution and conducted a diagnostic survey on the attractiveness and use of these applications in natural science lessons - this study included 100 middle school students divided into 10 focus groups.

The research was based on the analysis of documents (intrusions and mobile applications that are available to students). Their abilities and uses were categorized and categorized based on the information that can be obtained. Then the students had the task of preparing an air condition analysis using their mobile application or a website dedicated to air pollution. The reports prepared by the students were analyzed and the final phase of focus interviews was conducted with the students.

Results of Research

There are many websites available that offer a variety of functions that can be used by teachers and students in the education process. Most applications and websites allow you to read the state of pollutants and compare them with the applicable standards and show the situation in other Polish cities. About 50% of web pages about smog and the possibility of studying its content in the air were learned during the interview - students learned only from television before.

Research has shown that high school students are eager to use smog-enabled mobile applications, although 20% of them have never heard of this type of application before, and have begun using them only after participating in a focus interview. More than half of the survey participants believe that they will be more likely to use such mobile applications to increase awareness of air pollution in their place of residence. Students were more eager to use mobile applications than interstices, indicating easier access to information, updated data on time and place of residence. The respondents pointed out

that the applications helped them to understand what impurities could be in the air and what their standards were.

Conclusions and Implications

Mobile applications are a good educational tool used to stimulate students in the field of natural sciences.

The Internet environment and easy access to mobile applications are attractive to young people, which in turn generates greater involvement of students in observation and analysis of the state of the natural environment.

Mobile applications affect the raising of environmental awareness about the state of air pollution among young people.

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ANALYSIS OF SCIENCE VIDEOS PRODUCED BY BRAZILIAN MINISTRY OF EDUCATION

Marcus Vinicius Pereira
Instituto Federal do Rio de Janeiro, PROPEC-IFRJ, Brazil
E-mail: marcus.pereira@ifrj.edu.br

Agnaldo Arroio
University of São Paulo, Brazil
E-mail: agnaldoarroio@usp.br

Abstract

It is presented an analysis of science videos produced by Ministry of Education of Brazil to prepare high school students for an exam. It was identified how these videos were produced under filmic analysis framework. They are long duration videos, more similar to TV programs, which incorporate popular Youtube videos to solve problems inset with the dialogue between a presenter (an actor) and a teacher. Also there is weak relation between the guest interviewed and the video subject.
Keywords: *media literacy, filmic analysis, science education, Youtube.*

Introduction

Nowadays it is possible to find a variety of audiovisual resources in repositories such as Youtube and Vimeo produced to contribute to the science teaching and learning process, mostly classes recorded in video or problems solving commented by teachers (Eick & King Jr., 2012). Although they do not represent any innovation compared to traditional classes, the large number of accesses reflects the users' demand for these materials, which leads individual audiovisual production, initially unpretentious, to become professionalized, commercializing these videos by packages and subscriptions on their websites. This phenomenon is supported by a discourse that emphasizes objectivity, clarity and quality of content, enhances interactivity and promises dynamic and personalized teaching (Shereer & Shea, 2011). However, there are those who share a more pessimistic view when they consider that this avalanche of materials may stigmatize the teacher as a mere reproducer when he is not also engaged to produce his didactic materials.

In 2016 in Brazil there was a governmental initiative to create a platform called Enem Time to prepare students for the National High School Examination (Enem) used as a mechanism for university access. There, it can find news about Enem, videos produced for each high school subject by the TV School of the Brazilian Ministry of Education (MEC) in partnership with Roquette Pinto Foundation, in addition to a video repository nominated Mecflix (analogy to Netflix) which brings together videos available

on Youtube and Vimeo, many of them produced by Khan Academy. The lack of research about audiovisuals produced for Enem Time, an exploratory study was conducted about science videos in order to understand what they mean in the discourse they present for effective changes or improvements in the Brazilian educational system.

Methodology of Research

Although the Enem Time platform has its own website (http://horadoenem.mec.gov.br/), all the videos produced are available on its Youtube channel and categorized into playlists for each high school subject (https://www.youtube.com/channel/UCzd90_uBwdyCnBbObCTfVDA). Thereby it was proceeded to an exploratory research of the videos in biology, physics and chemistry playlists to delimitate a research object that intends to problematize and analyze audiovisual resources with pedagogical purposes available in the World Wide Web.

It had mapped the Enem Time videos in terms of quantity by discipline and number of views, and then they were analyzed according to Vanoye and Goliot-Lété (2009) filmic analysis framework, which proposes non-centrality in the audiovisual text, taking into account also the context in which the work was produced and trying to identify the influences of this in the composition of the text. In filmic analysis the work was destructed in its parts and then it was rebuilt to understand the whole work from the synthesis of its parts.

Results of Research

Until the beginning of April 2017, it was found 19 videos on the Enem Time Youtube channel, 7 of biology, 6 of physics and 6 of chemistry. Despite the MEC's effort to produce these materials, this is not reflected in its use by students, since each video a few units of thousand views, contrasting with the hundreds of thousands that educational channels like UNIVESPTV and Descomplica have in their videos. Also noteworthy is the long duration of the videos, on average 25 minutes, which seems to go against the most popular educational videos on the internet, which are usually short duration, approaching a specific theme, aiming not to disperse the attention of the viewer and solve the question that leads the user to search the video.

The filmic analysis of the Enem Time videos allows to understand this contrast. The aesthetic model of all videos, regardless of the high school subject, follows the same line: a short opening containing scenes of apparatus and objects related to science; a young black man actor, in a casual way, introduces the program in a scenario that resembles a laboratory / study room; a teacher is invited by the presenter; dialogue between the presenter and the teacher seeks to clarify better ways of learning the theme; solving Enem questions by another teacher in an embedded video that was not produced by the Enem Time; dialogue between a guest and the presenter in an interview tone, contextualizing the theme or showing its application in other areas of knowledge; closing / final credits.

The production more resembles a TV show than an educational video dedicated to teaching biology, physics, or chemistry. In 17 of the 19 programs, videos from Youtube educational channels Descomplica and Enem HQ were embedded to solve questions

of previous exams. These channels are well known among the Brazilian students who are getting ready for Enem. The dialogue between presenter and teacher switches to the embedded video, and the teacher makes some comments about the problem resolution. Finally, the presenter invites a guest and starts a dialogue in an interview tone, which seems be more motivational about the importance of the subject for the student than for the teaching of the theme itself. It is unnecessary the presence of a guest in all videos, since it makes the video long and does not make clear the relation with the subject addressed, the content of the dialogue is more general than that of the video theme. On the other hand, it is highlighted as a positive aspect the incorporation of people of various ethnicities and different regions of Brazil which is a continental dimension country.

Conclusions and Implications

The model adopted by the science videos of the Enem Time seems to be decisive for the difficulty of its dissemination, evidenced both by the low number of accesses and the almost non-existent comments on Youtube. The film analysis allowed to infer that these videos are far from the reality of the people, who look for materials to get ready for the Enem exam. The context of video production seems to take into account more the university than the school, since the teachers have masters or doctors' degrees and they work in federal technical schools (best public schools in the country), and the guests are researchers of a university or a research center or even a professional of related area to the topic of video for the most part.

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NATIONAL LEVEL TEST IN SCIENCE IN LATVIA FOR ASSESSING HOW STUDENTS EXPLAIN PHENOMENA SCIENTIFICALLY

Pavels Pestovs, Dace Namsone
University of Latvia, Latvia
E-mail: ppestovs@gmail.com, dace.namsone@lu.lv

Abstract

For successful curriculum implementation in the framework of the project "Competency-based Education Curriculum Development and Implementation" funded from the European Social Fund (ESF), it is essential to develop validated and reliable national level tests with an objective to monitor students' progress. The purpose of the research is to analyse students' current situation in explaining natural phenomena scientifically in order to give a clear insight into the assessment process of students' skills. At a first glance, a substantial amount (more than 50 %) of 15-16 years old students are capable of explaining natural phenomena in science, however, detailed analysis reveals two problems: both deep and surface student explanations are scored in the same way in test and item assessing criteria are not allowing teachers to assess student skills at different cognitive levels.
Keywords: *explaining phenomena scientifically, natural phenomena in science, skill assessment.*

Introduction

In the framework of PISA (OECD, 2016b) scientific literacy is defined from the point of view of three competencies: explaining phenomena scientifically, evaluating and designing scientific inquiry and interpreting data and evidence scientifically. One of the project's "Competency-based Education Curriculum Development and Implementation" goals is to develop 20 diagnostic tests in order to diagnose students' skill in different ages, 50 % from all diagnostic assessment must be acquired in science, technology, engineering, and mathematics (STEM) area. It is out of the most importance to analyse previous national level tests in order to acquire the insight into the diagnostic system in Latvia. There is a huge gap between national mean percentage in scientific diagnostic assessment of the 15-16 year old students and in OECD PISA results, it is crucial to understand the reason to this difference.

Continuous assessment of students is essential for planning better strategies in student teaching and learning practices. In Latvia, there have been used different assessment strategies, and there are hardly founded evidences that the assessment is shifted only for "teaching for a test". However National Centre for Education has information about variable marking of diagnostic tests, which have been assessed in school by teachers, which reduces the usefulness and reliability of the information (OECD, 2016c). Comparing the results of the national diagnostic tests and PISA national results in Latvia reveals controversial information at a first glance, but in-depth analysis reveals the difference of methodology and possible explanation about the information and interpretation of it (OECD, 2016a).

The main difference in student skills who are acquired 5th and 6th level proficiency scale level in science, is capability of using abstract scientific ideas or concepts to explain unfamiliar and more complex phenomena, students can offer explanatory hypothesis of novel scientific phenomena from a range of scientific ideas (OECD, 2016b).

The purpose of the research is to find out experience in assessing scientific skill to explain natural phenomena scientifically in Latvia and to analyse the risks and restrictions in today's system in order to plan changes in a system of national level test.

This research addresses the following research questions:

1. What results do students demonstrate in test items, which are related to explaining scientific phenomena?
2. What information about students' skill to explain phenomena scientifically is given from national level test to improve testing system?

Methodology of Research

National assessment diagnostic test 2017 results for the 15-16 years old students have been analysed in this research. Student national test papers are checked by teachers in schools and scores are delivered for the National Centre for Education of the Republic of Latvia, using electronic system.

The test was completed by 15403 students, with the 35 test elements and maximum score 35 points. Items have been analysed using Classic Test Theory (CTT) and Item Response Theory (IRT) Rasch model.

Correct percentage, discrimination index, percentage endorsing high and low performance have been estimated using ITEMAN program for the CTT. Difficulty parameter (eta) with SE with confident interval (CI) 0.95 has been estimated for each item using freeware R program for the IRT Rasch analysis.

The interest of this research were items with negative IRT Rasch analysis difficulty parameter, in which student ability or attainment level is higher than the item difficulty and where students are explaining natural phenomena scientifically. From the range of items, seven the easiest items were selected, which are related to explaining natural phenomena scientifically. Items, which demand students' skill of explaining natural phenomena scientifically and different level of cognitive demand, using both SOLO taxonomy criteria (Hook & Mills, 2012) and Analytical Framework of PISA assessment (OECD, 2016b), were chosen and characterized.

In depth have been analysed 230 papers from 8 schools, both teacher marking scheme and students answers depth were analysed.

Results of Research

Mean score in national diagnostic science test 2017 is 16.7 points with standard error (SE) 5.4. About 25 % of items according to IRT Rasch analysis student ability is higher than the item difficulty. Item characterisation according CTT and IRT Rasch analysis are compiled in Table 1. From the Rasch analysis item-person plot is revealed not enough resolution to the group of students with low and high performances.

It is very useful to get to the point at assessing scientific literacy providing students with tasks with different cognitive demand: low, medium and high.

Table 1. Characterisation of the test elements of the National assessment.

	SOLO taxonomy	Cognitive demand PISA	Percentage correct, %	Discrimination index	Percentage endorsing low performers	Percentage endorsing high performers	Difficulty parameter	Difficulty parameter with SE
1	Multistructural	Medium	75	0.41	51	92	-1.649	0.019
2	Multistructural	Low	65	0.46	39	84	-1.121	0.017
3	Multistructural	Low	65	0.46	39	85	-1.116	0.017
4	Relational	Medium	63	0.37	43	80	-1.046	0.017
5	Relational	Medium	57	0.52	30	82	-0.773	0.017
6	Unistructural	Low	54	0.39	34	73	-0.627	0.017
7	Relational	Medium	54	0.45	30	75	-0.609	0.017

In-depth analysis of student answers, reveals that a certain percent of answers are not checked correctly by teachers, mostly answers in explanation are unistructural or multistructural according to SOLO taxonomy. It is a rather general practice to score with full credit answers, only if one word hardly matches the explanation. In such practice, we are not capable of evaluation student skill reliably. In-depth analysis of 230 student papers, using SOLO taxonomy, reveals that less than 10 % of students were able to answer the questions using two and more science concepts, demonstrating relational and extended abstract generalisations. For example, test item, when students are asked to analyse how it is possible to accelerate oxygen production in green plants, using bulb lamp. Two students get maximum point scored for the answers: placing green plant under the Sun and changing the power of bulb lamp and time during the experiment. In future researches it is important to develop reliable rubrics in skill assessment to use them both: in classroom practices and in the national test level.

Conclusions and Implications

In the future for the successful developing and implementation new national curriculum, it is highly important, to drive changes which are based in evidence. Longitudinal research, which allow monitoring student progress, using data from validated and reliable diagnostic test system is a priority in Latvia. It is highly important to develop a diagnostic system, not only in the area of content knowledge, but also in measuring skill development, which requires gathering additional evidences and information. Hattie's research conclusions about weak skill transferring from different areas is strongly related to the practices in classroom, in order the students had opportunities for training in different areas.

In-depth student paper research reveals, that only few student demonstrate formulating arguments from different conceptual perspectives, demonstrating high level of proficiency scale for science according to PISA framework, therefore using only information about high correct percentage and difficulty parameter are rather misleading.

For future research possible solution in order to develop national level test system is to introduce and adopt electronic testing system in order to use authentic student paper answers and solutions, develop criteria for selection representative student range.

In research literature, surprisingly little is known about how skills are delivered in classroom and how these skills have been assessed in the classroom. For example, problem solving skills are not so well correlated, as it would be expected, with mathematics and science competency (Csapo & Funke, 2017). In future, developing a national level test for skill assessment, essential component is collaborating with psychology experts and teachers in order to validate items, cognitive demand and correlate everyday teaching learning practices in classroom.

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NATURAL HISTORY MUSEUMS AS A SPACE OF SCIENCE EDUCATION IN THE KNOWLEDGE-BASED SOCIETY

Katarzyna Potyrala, Karolina Czerwiec, Renata Stasko
Pedagogical University of Cracow, Poland
E-mail: karolinaczerwiec@gmail.com, potyrala2@wp.pl

Abstract

The museum activity is more and more often aimed at integration with local communities, organization of scientific debates and intercultural dialogue, expansion of social network and framework for communication and mediation of scientific issues. Museums generate learning potential and create a social culture. The aim of the research was to diagnose the viability of natural history museums as the spaces of open training and increasing social participation in education for balanced development. Furthermore, it examined the possibility to create a strong interaction between schools at all levels and institutions of informal education, exchange of experience in the field of educational projects and the development of cooperation principles to strengthen the university-school-natural history museum relations. In the research conducted in the years 2016-2017 participated 110 students of teaching specialization in various fields of studies.
The results of the research are connected with students' attitudes towards new role of museums as institutions popularizing knowledge and sharing knowledge. The outcomes enable the diagnosis in terms of preparing young people to pursue participatory activities for the local community and may be the starting point for the development of proposals of educational solutions increasing students' awareness in the field of natural history museums' educational potential.
Keywords: *knowledge-based society, natural history museum, science education.*

Introduction

In a European context the following points of reference should be reflected in the design of science education processes: 1/ ethical acceptability which includes compliance with both the EU charter on fundamental rights as well as the safety of open schooling and science education; 2/ orientation towards societal needs which includes an orientation towards contributing to achieving objectives of sustainable development.

Due to the fact that the research is focused on open schooling and new role of science museums in the area of science education, it's necessary to analyze the definition and main aspects of open sources of information and the process of transformation the traditional museums in the knowledge sharing platform during the building of knowledge-based society.

Firstly open sources of information refer to the comprehensive approach of proceeding in research in ways that allow all stakeholders that are involved in the processes of research at an early stage. It enables:

- to obtain relevant knowledge on the consequences of the outcomes of their actions and on the range of options open to them,

- to effectively evaluate both outcomes and options in terms of societal needs and moral values,
- to use these considerations as functional requirements for design and development of new research.

Natural history museums as a platform for knowledge are going through a global transformation in developing creativity, partnership, integration and critical reflection of their audience. The key role of museums is therefore to spread the culture necessary for the further social development (Winther, 2013). Training of museum staff and biologists should be interdisciplinary and occur not only "for the past" but above all "for the future" (Krishtalka & Humphrey, 2000). It is also important to develop a balanced model of interaction of all participants in popularizing knowledge through museums (Alpert, 2009; Feldman et al, 2012; Powers et al., 2013). Popularization of science involves the search of forms suitable for announcing the scientific achievements to various groups of audience. An important issue is the ability to convey scientific information in a form that is attractive for the recipient and raises interest. A significant aspect is also promotion of principles of engaging education. It is crucial to create opportunities for overcoming difficulties through the "therapy" which uses the abundance of the science world offered by natural history museums (Potyrała & Czerwiec, 2015).

The Main Problem of the Research

The main problem of the research was concerned on the question about students' attitudes towards the role of new type of science museums in knowledge-based society building and their educational priorities connected with the transformation of traditional science museums in the knowledge sharing platform.

The Objectives of the Research

The objectives of the research were following:

- to create the rules of cooperative community in the field of Science Education, what enables to foster sustainable interaction between research institutions, institutions of informal education, schools and open public and diagnosis of the current state in this area,
- to select the best practices from different educational institutions what enable them to exchange knowledge and transfer experience from their projects and research,
- to elaborate criteria system in the area of open schooling, what enables European researchers to undertake the educational issues connected with Science Education (in particular the health, sustainable development, ICT in science education) in responsible and interesting way,
- to examine the attitudes of students towards social participation due to the new forms of informal education (science museums).

Methodology of the Research

The following hypothesis was verified during research: students' attitudes towards communication of the scientific problems through the new types of science museums is a big challenge in the context of knowledge-based society. The social needs create the new type of museums staff and new type of policy in the range of knowledge sharing platform what is priority.

Research Strategies and Methods

The main methods are: diagnostic survey, focus interviews and pedagogical observation. The pedagogical observation concerned activities undertaken in teaching classes in the field of concepts and practices of education and teaching which were attended by 110 students of teaching specialization in various fields of studies. The subjects of the observation were different forms of communication conducted through different media, using diversified communication platforms, occurring in different learning environments, among people of different ages and with different social status.

The students were divided into 6 groups whose task was to fill in the observation sheets which were developed by educators of particular subjects. Thematic areas concerning the observation were: 1/ Museum exhibitions and methods of their presentation; 2/ Conducting scientific event; 3/ Creativity of activities for natural environment preservation and increasing the level of social participation; 4/ Ways of promoting cultural and social activity; 5/ Creating connections between science and art in museums' activities which go beyond exhibiting; 6/ Interpersonal and organizational skills, abilities to create educational environment, communicativeness, creativity of museum staff.

In the diagnostic survey the students were asked about the kind of media and the type of messages which significantly affect interests, skills and attitudes of learners (especially in the context of education for balanced development related to the animation of the local community, open schooling and motivation for using museums' offer). Also, the survey asked about the need for searching and testing new ideas in teacher's work due to changes in conception of learners, mainly in relation to changes in the perception of educational role of natural history museums and changes in methods and forms of conducting museum education.

The research was conducted in the years 2016-2017. The first stage was the diagnosis of students' knowledge and attitudes in the field of museum education. Then, during lectures and training related to the concepts and practices of education and teaching the students were introduced to the subject of transformation of modern museums and issues of social participation. The next stage of the study were visits of the students in places non-formally and informally popularizing knowledge in which they conducted pedagogical observations and interviews with the staff of individual institutions. The final stage of the study focused on the diagnosis of changes in the students' attitudes in relation to the ways of communicating science which they learnt about.

Results of the Research

Analysis of the results obtained so far has shown that almost all of the students participating in the research agreed that there is an urgent need to create new types of museums tailored to the conditions of the present day, especially in the context of means of interdisciplinary knowledge communication and creating offers of natural history museums for members of knowledge society. At the same time they noticed a progressive process of transformation of Polish natural history museums and science centers in terms of used forms of communication, rules of visiting or involving visitors in animation on their premises. However, the students concluded that it is essential to pay more attention to strengthen cooperation between schools and institutions of informal education in the field of environmental education. Realization of consecutive stages of the research will clarify the priorities of natural history museum transformation as a platform for knowledge exchange and a more complete diagnosis of the current state of environmental education in educational institutions and ways to transfer the experiences between them.

Conclusions

Thanks to the participation in the research students learned that the process of museum transformation is underway in Poland. Previously, they were unaware of this; they very rarely visited museums because their school experience was associated solely with the conviction that the visit to the museum is boring and does not involve students taking action.

The variety of activities undertaken in museums by the museum mediators cause that in the museums the scientific communication takes place - visitors can ask questions and seek answers themselves.

In museums there are more and more researchers telling the audience about their research conducted in laboratories. Therefore, young people can experience the research process outside of school. It is so valuable because school curricula does not leave too much time for additional activity for students.

It is essential to train teachers in the use of places such as museums in the school practice. Teachers should know how to do this and realize that museums are a great platform for sharing knowledge.

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CHEMICAL EQUILIBRIUM IN TERMS OF ITS CONCEPTUAL UNDERSTANDING IN THE CONTEXT OF SUBMICROSCOPIC, MACROSCOPIC AND SYMBOLIC INTERPRETATION BY LEARNERS

Miroslav Prokša, Zuzana Haláková, Anna Drozdíková
Comenius University in Bratislava, Slovakia
E-mail: proksa@fns.uniba.sk, halakova@fns.uniba.sk

Abstract

The research was focused on solving the following research question: What is the depth and breadth of 16-year-old learners' knowledge of the chemical equilibrium in Slovakia? The main aim of our research was to find out the conceptual understanding of this part of chemistry in the context of submicroscopic, macroscopic and symbolic representations. A special research tool, which consisted of five sets of tasks, was created for this research. The research included a sample of 473 children. The results indicate that knowledge is more at the level of memory reproduction and algorithmic use. Learners have been facing a problem with the conceptual understanding of the given concept.
Keywords: *chemical equilibrium, submicroscopic, macroscopic and symbolic interpretation, conceptual understanding.*

Introduction

In the curriculum of general chemistry the concept of chemical equilibrium is considered one of the most difficult to understand and yet one of the most important (Özmen, 2008 Garnett et al. 1995 Solomonidou, Stavridou, 2001). Several researchers justify this fact by its abstraction, interconnections with other hierarchically subordinate concepts (e.g. Quilez-Pardo, Solaz-Portolez, 1995) such as system, reaction, mixing, reversibility, dynamics (Pedrosa, Dias 2000) as well as by the fact that the chemical equilibrium is the basis for understanding of other chemical concepts (acids, bases, solubility, redox reactions, etc.) (Voska, Heikkinen, 2000). Moreover, many students also classify the chemical equilibrium among the concepts difficult to understand (Bilgin et al., 2003).

In the field of chemical equilibrium, researchers have identified several misconceptions: Griffiths (1994) 5, Özmen (2008) 17. For example, Pedrosa and Dias (2000) identified 33 problematic words or phrases in Portuguese chemistry textbooks; Bilgin et al. (2003) highlighted 10 areas in chemical equilibrium where misconceptions arise. Other misconceptions concern the approach to chemical equilibrium, characteristics of chemical equilibrium, understanding the conditions of change in chemical equilibrium, the role of a catalyst (Bilgin, Uzuntiryaki, Gebana 2003), the notion that the reaction can proceed backward only if the forward reaction is terminated (Niaz, 2001) as well as predicting the conditions of equilibrium (Banerjee 1991). They also include distinc-

tion between the conditions that characterize completion and reversible reactions, the impact of factors on the value of the equilibrium constant as well as an idea that in a state of chemical equilibrium there is a simple arithmetic/linear relationship between the concentrations of reactants and products (Hackling, Garnett 1985). According to Bilgin et al. (2003), the topic of chemical equilibrium is unique because when teaching the misconceptions may occur due to the similarity with everyday experience as well as the abstractness of this phenomenon.

Research conducted all around the world also points out to the fact that children, students (Bilgin et al. 2003 Ghirardi et al. 2014), pre-service (Banerjee 1991 Özmen 2008) as well as in-service chemistry teachers (Özmen, 2008) face a problem with understanding the submicroscopic and symbolic levels of chemical equilibrium, because they are abstract and the students as well as the teachers miss sufficient experience with them. The most common measuring tools to detect the chemical equilibrium misconceptions include either two-level tests, open-question interviews or worksheets.

This situation could be enhanced by intentional linking the submicroscopic, symbolic and macroscopic representations (Gabel, 1999) and the use of computer simulations applied to system visualization, strategies of conceptual changes, e.g. practical laboratory activities. In addition, dismissing the reduction of chemistry to a mere world of symbols and equations in textbooks as well as avoiding vague or confusing interpretations (Pedrosa, Dias 2000) can also play a significant role.

Aim of Research

The research was focused on solving the following research question: What is the depth and breadth of 16-year-old learners' knowledge of the chemical equilibrium in Slovakia? The main aim of this research was to find out the status of conceptual understanding of the chemical equilibrium by second-graders in Slovakia, especially in the context of submicroscopic, macroscopic and symbolic interpretations of chemical equilibrium.

Methodology of Research

As a research tool five sets of learning tasks were used in our research. Each set consisted of partial tasks reflecting the memory reproduction, algorithmic level and conceptual mastery of selected nodes related to chemical equilibrium. From another point of view, the subtasks of some sets had a character of the two-tier tasks. In addition, each set of tasks involved at least two levels of representation of the studied knowledge at the same time – the combination of macroscopic, submicroscopic and symbolic levels of representation. In terms of the subtask format, there were two format types – either open-ended questions, or a multiple choice.

The objectives of individual sets of tasks were structured in order to check conceptual mastery of the concept of chemical transformation, to identify the understanding of a concept of incomplete chemical change, reversibility of some reactions, to recognise the conceptual mastering of the state of chemical equilibrium for reaction systems at different temperatures, especially in the context of algorithmic knowledge about how to determine the thermal effect of reactions and an algorithm for shifting the chemical equilibrium due to changes in temperature, to map the state of the conceptual mastering

of the equilibrium constant in the context of interpreting the extent of metabolism, to detect the conceptual mastery of the impact of pressure and concentration on the equilibrium system.

The research, involving a total of 473 students, was done at Slovak secondary schools in early 2017. The measurement was carried out half a year after the related topic was taught to the learners.

Research Results

The results suggest that learners' mastery of the concept of chemical equilibrium is in Slovakia connected with isolation of submicroscopic, macroscopic and symbolic representations of chemical equilibrium. Slovak learners have been facing problems with the conceptual understanding of chemical equilibrium. The problem is that they do not understand the nature of reversible reactions, which is also reflected in the symbolic level of representation, although their understanding of one-direction reaction is at an acceptable level. In connection with understanding the importance of equilibrium constant, we identified problems already at the memory level (41.99%). The conceptual understanding of the equilibrium constant-temperature relationship was even worse – making up to 61.95% of incorrect answers. Moreover, learners´ understanding of the significance of the numerical value of equilibrium constant to interpret the ratio of reactants and products in the equilibrium mixture is not satisfactory either (incorrect interpretation 47.78%). Regarding the impact of pressure on chemical equilibrium, a larger proportion of children (88.00%) were able to combine submicroscopic and symbolic aspects.

However, only 15% of the sample showed correct or at least partially correct application of these representations to explain the impact of the pressure changes on the given gaseous equilibrium system. The overall interpretation of the analysis of results, mostly focused on detecting learners' interconnection of macroscopic and symbolic representations of chemical equilibrium, revealed a very weak mastery of this aspect of the related concept (only 6% of conceptual understanding).

Conclusion

Research results confirmed us in the need to further examine the issue in order to help teachers in upgrading the methods and tools providing conceptual mastery of the concept via linking all three levels of representations of the chemical equilibrium.

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VARIOUS KINDS OF PROBLEMS IN AN ELECTRICITY AND MAGNETISM ASSESSMENT WITHIN AN INTRODUCTORY PHYSICS COURSE FOR CHEMISTRY MAJORS

Lukáš Richterek
Palacký University Olomouc, Czech Republic
E-mail: lukas.richterek@upol.cz

František Látal
Basic school Kvasice, Czech Republic
E-mail: latal@zskvasice.cz

Abstract

An assessment is described in the introductory physics course for chemistry major students with the focus on solving problems from the electricity and magnetism. The experiences are summarised, obtained during the academic years 2014/2015, 2015/2016 and 2016/2017 from a multiple-choice test passed by 390 chemistry majors at the Faculty of Science in Olomouc. Various kinds of quiz problems were used, which can be divided into three categories: conceptual questions, numerical questions, questions with chart reading and interpretation. In the study assessment data are summarised and the score difference, achieved in the mentioned problem categories, is identified. The results did not prove that conceptual problems were more difficult for the set of students, but it is suggested, that students are more successful in the whole test to reach better scores in graph reading questions.
Keywords: *chemistry majors, physics course, university students.*

Introduction

Multiple-choice tests can be a useful tool in assessing what students learn in physics courses. A number of such tests have been developed, covering different physics domains. Electromagnetic concepts are, unlike those in mechanics, generally not a part of students' everyday language and experience, and students are therefore less likely to have strong preformed concepts in electromagnetism than they are in mechanics (Jelicic *et al.*, 2017). Moreover, electricity and magnetism is a rather broad conceptual area that relies on understanding in other domains such as force, motion and energy (Maloney *et al.,* 2001). Some researchers have disclosed, that the schoolchildren and high school students frequently misinterpret the content of some concepts (e.g. current source, resistance), do not distinguish between two different concepts (electric current, electric energy), refer to the wrong views and misconceptions, etc. (Šlekiene & Raguliene, 2006).

To make students' assessment as much objective and balanced as possible, various kinds of quiz problems are used, which are divided into three categories: conceptual

questions, numerical questions, questions with chart reading and interpretation. In this report assessment data are summarised and the score difference, achieved in the above mentioned problem categories, is identified.

Methodology of Research

One-semester courses are designed with the aim to provide the first year students of chemistry with basic knowledge of physics. It has to be considered, that students' knowledge in basic physics is rather varying as they come from different secondary schools. The content of the course covering electricity, magnetism, optics and introduction to atomic and nuclear physics issues is based on the Czech translation of the classical American textbook (Halliday, Resnick, & Walker, 2007) with some adaptations to the chemical context (e.g. leaving out some calculus based problems connected with electric or magnetic fields of various sources and adding electrochemical Faraday's laws). In addition, the critical role of the fundamental principles of physics are tried to be emphasized, and also it is tried to develop students' quantitative and problem solving skills.

Some students in introductory physics classes, especially non-physics majors, are often less comfortable with the so called conceptual problems, designed to assess student understanding of the most basic concepts. More often the students are used to getting numerical results (a typical example of such assessments are the entrance tests in physics at Czech faculties of medicine). As a canonical example of conceptual problems, items in the famous FCI test (Hestenes *et al.,*1992) are taken, in the course, some conceptual tasks from already tested electricity and magnetism assessments e.g. (Ding *et al.*, 2006, Li, & Singh, 2017; Maloney *et al.,* 2001) are used. To support and help to solidify conceptual understanding also peer-led discussions are included in some lectures. The teaching methodology of peer instruction (Mazur, 1996; Zhang, 2017) has been proved as successfully applicable to a variety of introductory science courses (including physics for biology and chemistry majors).

Within a limited time of a one-semester course and a wide amount of topics to be covered, a set of suitable homework tasks can become a key learning tool for students as it allows students' active participation in the learning process. Therefore, to provide some training for the quiz assessment, we also use multiple-choice homework tasks in the Moodle learning environment. To make the plagiarizing during the assessment more difficult, two similar variants of the test were taken by about 50 students for each variant in every academic year. While the test in the academic year 2014/2015 included more problems on static electricity, charge and circuits topics, the test in the academic year 2015/2016 included more problems on magnetism.

Standard test analysis was applied to all six variants of the test used within last three years according to previous researches with similar objectives, e.g. (Aubrecht & Aubrecht, 1983; Ding & Beichner, 2009; Maloney *et al.,* 2001). Such characteristics like item difficulty indexes, item discrimination indexes and item tetrachoric correlation coefficients following the "cosine method" (Davidoff & Goheen, 1953; Jeřábek & Bílek, 2010) were calculated and compared within problems categories for all 20 items in each of the six variant of the test. The Kuder-Richardson reliability index of all test variants was around 0,9, which can be considered as quite satisfactory.

Results of Research

The analysis of the results did not prove that conceptual problems were generally more difficult for the set of students. Moreover, according to the tetrachoric correlation coefficient the conceptual problems were not the ones with significant differences between students with high and low overall scores; some of those tasks came out with low difficulty index, but for both above mentioned groups of students.

On the other hand, chart interpretation problems were mostly among the questions with the highest tetrachoric correlation coefficient.

Conclusions

The results support the conclusion that interpreting graphs plays an important role in science teaching as well as in science practice for many reasons – scientific reasoning and communication. In the tests, successful reading and interpreting of the graphs was one of the factors distinguishing students with higher and lower overall scores in the assessments. This suggests that graphing should be more emphasized in science instruction, which is consistent with some previous analysis (Beichner, 1994; Lai *et al.*, 2016). It can also be concluded, that a reasonably reliable and complex multiple choice assessment for electricity and magnetism in an introductory course has been developed and combines various categories of test problems.

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CHALLENGES IN ASSESSMENT AND GUIDANCE IN STUDY GROUP BASED LEARNING

Antti Rissanen, Kalle Saastamoinen
National Defense University, Finland
E-mail: antti.rissanen@mil.fi

Abstract

In science and technology education lectures, exercises, and report type home works are aimed to guide individual learning in knowing applied methods and tools to gain knowledge and skills needed in future profession. This research presents observations how flipped learning and group work would solve some of the motivation and resource related challenges in the NDU's master level curricula in the department of military technology. However, feedback studies from recent courses showed that assessment, guidance, and even controlling procedures are needed when applying these methods. Action research methodology was used to seek solutions to the new challenges produced by student centric education like flipped and group work type approaches. Observations were made from the NDU's two year long, preprogrammed, and mostly preplanned curricula. The research revealed that in NDU many aspects in group based models required deeper consideration. Especially, related individual assignments, assessment methods, and motivational aspects formed some of the critical areas.
Keywords: *group work, assessment methods, student centric learning*.

Introduction

The National Defense University (NDU) is a training institution responsible for educating the future leaders of Finland's armed forces. Master level studies start after bachelor studies when the students have made four years in officer's profession. Academic studies are combined with practical skills in leadership and tactics. The learning aims in technology in master level may be expressed in three equally important parts, which should not be separated: 1) gaining applied scientific knowledge, 2) understanding how technology utilizes scientific results, and 3) further ability to manage practical exercises within the working environment. Due to motivational as well as resource related demand exercises, home work, and reports are asked to do in certain courses in small groups. At the moment 6 full courses with the Bologna declaration principles have been done using these methods. Piloting 2009 with a relative small group (11 students) in military technology since the group size has gradually grown. The future group size in military technology will grow to almost 48 students. Therefore, in long run it is impossible to give individual guidance in every aspect.

It is emphasized that in generally work-group based education requires knowledge on group dynamics, attention how to apply assessment methods as well as on discipline and course specific instructional tactics (e.g. Ulrich & Glendon, 2005). In this research these issues were under evaluation. The main purpose of this research was to define what

kinds of challenges flipped and group-based education styles may contain in NDU's context and what kinds of actions are needed when trying to apply these educational approaches more successfully.

Methodology of Research

Technology and science courses at NDU are relatively short and intensively scheduled year after year. So observations can be systematically analyzed with the interventions. Action research is designed to bridge the gap between research and practice. Action research forms a spiral of process stages in which the process may not be as neat as the spiral of self-contained cycles of planning, acting, observing, and reflecting suggests (e.g. Kemmis & McTaggart, 2005). In this research, different group work practices, examination protocols, and course feedback were studied to provide better knowledge of such kinds of learning environments. These items are related to the structure of how our teaching should be applied in future. Remarks were made from three short courses held as a part of 7 Master of Military study courses between 2009 and 2017. The total amount of participants was 110. Observations were focused on learning results, motivational aspects, and common impressions of courses. It is known that student evaluation of teaching (SET) in higher education has still issues concerning its validity (Spooren, Brock, & Mortelmans, 2013). Nevertheless, standard SET questionnaires in NDU's Learning material portal (Moodle) were used for data collection, comparison, and storing data from each course. Qualitative conclusions were formed from multiple sources and furtherly main findings were discussed with the instructors and students to verify that facts behind both formative and summative results were relevant.

Results of Research

Learning material system (LMS) may help to provide general guidance for students. Mainly it is noticed as a way to deliver digital material to students and to collect reports from learners. In these courses LMS was used to enhance distance education parts and student centric activities. However, too dedicate but unclarified aims and concentration just on group work methods as such may ruin motivation. Gradual move from traditional face to face lectures towards flipped learning in a larger group would work when proper guidance and control procedures are developed and provided for learners. The role of distance education and the way to use LMS was not fully clear either to instructors or students. Also, assessment requires special attention so that each section of study work is represented in final grading. Less guidance with minimal amount of normal lectures may produce long term mistrust among students even when learning aims are achieved.

Conclusions and Implications

Group work as it is does not mean better results or enhanced motivation. Ability to choose the best practices for each studying context means a process of continuous evaluation. Guidance and clarity in aims and applied tactics are needed. During any course continuous attention on gained (even intermediate) learning results and motivational aspects may reveal hidden problems. Especially, individual homework which was in

most cases connected to smaller study groups would require such practices which could boost student satisfaction.

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CHEMISTRY AND MATHEMATICS: MATHEMATICAL CONTENT OF CHEMICAL TASKS

Oxana N. Ryzhova, Elizaveta A. Belevtsova, Nikolay E. Kuz'menko
M. V. Lomonosov Moscow State University, Russia
E-mail: ron@phys.chem.msu.ru

Abstract

The level of mathematical preparedness of secondary-school graduates influences not only the possibility of entering natural science faculties of university, but also the success of subsequent education. At present, when enrolling in Russian universities, the mathematical preparation of the entrant is assessed based on the result of the Unified State Exam. This research proposed to use the mathematical content of competitive chemistry tasks for indirect assessment of the degree of the university applicant's preparedness.
Keywords: *chemistry education, Unified State Exam, Chemistry Olympiad, entrance examination*.

Introduction

Recent reforms of educational system in Russia influenced the process of selection of applicants to the universities. Up to the beginning of the 2000's, all universities in Russia had controlled this process by conducting entrance exams, but now, the Unified State Exam (USE) in test form has become the main means for admission of applicants to all universities. Moscow State University can conduct one additional exam on profile subject in written form: for the Chemistry Faculty and some other natural science faculties profile subject is chemistry. However, it is very important to check the knowledge of future students in mathematics, because the university curriculum includes various physical and mathematical disciplines, mathematics is useful and often necessary for solution of many chemical problems (Eremin, 2014). Insufficient possession of mathematics does not allow students to master successfully chemical, physical, and mathematical disciplines. One of the ways to solve this problem is to control mathematical component of chemical tasks at the entrance chemistry exams.

The aim of the research was to find how the quantity and quality of the elements of mathematics necessary for solving the problems of entrance examinations and different-level Olympiads in chemistry have changed over time. In addition, it was supposed to study the correlation between the mathematical content and sections of the chemistry course program to which the problems are devoted.

Methodology of the Research

From 1990 to present, MSU Chemistry Faculty has published about 2500 tasks of the written entrance exams and Olympiads (for example: Kuz'menko, Terenin, & Ryzhova, 2006; Kuz'menko, Ryzhova, & Terenin, 2012). All these tasks were analyzed in order to reveal the dynamics of saturation with mathematical content. The tasks were divided into two groups: purely chemical problems without mathematical elements (represented mainly with chains of chemical transformations and theoretical questions) and the tasks, which include mathematical component. The second group was classified according to the type of mathematical operations needed to solve the tasks.

International Mendeleev Chemistry Olympiad for schoolchildren is a high-level contest in which winners of national Chemistry Olympiads participate each year. For example, in April 2017, 120 high-school students from 20 countries took part in 51st Mendeleev Olympiad in Astana (51st International Mendeleev Olympiad, 2017). The Olympiad consists of three tours, two theoretical and one experimental. All the tasks (for example: Lunin, Nenajdenko, Ryzhova & Kuz'menko, 2006) of the theoretical tours of last 15 years (up to 350 tasks) were analyzed and classified according to their mathematical content.

Results of Research

For 25 years the saturation of the examination cards with the tasks with mathematical content continually increased. So, in the early 1990s, an examination card consisting of seven tasks usually included two tasks with mathematical content. But now, the number of such problems within the examination card has increased to six of ten, and also the diversity of needed mathematical operations has grown.

It was found, that the mathematical content is correlated with certain chemical themes. For example, quadratic equations often arise when solving problems on the theme of "Electrolytic dissociation," "Solubility product" and "Chemical equilibrium".

The analysis of the theoretical tasks of the Mendeleev Olympiad showed that in 15 years the degree of saturation with mathematics did not change significantly. That is, this high-level Olympiad does not react to the growth of the application of mathematics in chemical science. It can be concluded that the noted increase in the number of problems with mathematical content and their complication is a reflection of the adaptation of the entire system of competitive selection to changes in the conditions of the formation of the university student contingent.

Conclusions

Under conditions of the absence of entrance examination in mathematics at the natural science faculties in university, the evaluation of mathematical competences of applicants can be performed by controlling the mathematical content of chemical tasks of entrance examinations and Olympiads.

Mathematical content of the tasks of chemistry Olympiads and entrance university examinations is very diverse, and for the last 25 years, the quantity of tasks with mathematical component increased from 30 to 60% of the content of the examination

card. This is not due to the growing use of mathematics in chemical science. This tendency can be seen as an adaptation of the system of competitive selection of entrants to modern educational regulations in Russia.

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INFLUENCE OF NANOTECHNOLOGY RELATED SSI PROGRAM ON COMPETENCIES OF HIGH SCHOOL STUDENTS IN KOREA

Hae-Ae Seo, Hye-Sook Lee, Soonok Kim
Pusan National University, South Korea
E-mail: haseo@pusan.ac.kr

Abstract

The study aimed to examine how a nanotechnology related SSI program influences on key competencies of high school students in Korea. Results showed that some competencies were significantly increased, while ability to work collaboratively in a group was not. Inclusion of a real life context and inquiry approach were important and specific instructional strategies which can develop certain competencies effectively. Implications for teaching such programs can be further discussed.

Keywords: *socio-scientific issues, competencies, nanotechnology, South Korea*.

Introduction

A changing, interdependent, and conflictual society today demands education reform. It has been criticized that the subject-bound curriculum offered by school barely prepares individuals to function well in such cases facing the present and future challenges at personal and societal levels. Indeed, individuals are not well educated to lead a successful and responsible life in a contemporary society after compulsory school education. The OECD Program DeSeCo (Definition and Selection of Competencies) was initiated in 1997 in order to equip students with new skills and competencies, which allow them to benefit from the emerging new forms of socialization and to contribute actively to economic development in the knowledge based society (Ananiadou & Claro, 2009, p5). OECD provides definitions for competencies needed in present and future society (OECD, 2005). A competency is more than just knowledge and skills. It involves the ability to meet complex demands, by drawing on and mobilizing psychosocial resources including skills and attitudes in a particular context. There are three key competencies: using tools interactively (e.g. language, technology), interacting in heterogeneous groups, and acting autonomously.

On the other hand, science education has increasingly focused on socio-scientific issues (SSI) as learning contexts. According to Oulton et al. (2004), society would benefit if science education encouraged students to adopt a more positive and realistic view of science and its potential for resolving conflicts. By promoting socio-scientific discourse in science learning, learners come to position themselves as active contributors to society with competencies and willingness to employ scientific ideas and processes, understandings about science, and social knowledge (e.g., ideas about economics, ethics) to issues

and problems affecting their lives (Sadler & Zeidler, 2009). Competencies required for scientific literacy in PISA 2015 are categorized into three: explain phenomena scientifically; evaluate and design scientific enquiry, and interpret data and evidence scientifically, in which a scientific literacy is defined as the ability to engage with science-related issues, and with the ideas of science, as a reflective citizen (OECD, 2016, p20).

In the similar context, a national science curriculum in Korea was revised as competency-based curriculum in science in 2015 to strengthen key competencies: scientific thinking ability, inquiry in science, scientific problem solving ability, communication ability, and life-long learning and participation in science. The competencies in science are likely to match key competencies in general across all subject matters: self-management ability, knowledge and information processing ability, creative thinking ability, sensibility, communication skills, and ability to work collaboratively in community. As a few programs adopting competency-based curriculum in science have developed in Korea, their effectiveness has not yet been investigated much. The study aimed to examine how a nanotechnology related SSI program influences on competencies of high school students in Korea. Technology in our contemporary society is rapidly developing and continuously changing. New technology keeps introducing new items in the market such as a washing machine using silver nanoparticles. Individuals are expected to deal wisely with manufacturer's claims in situations of considering purchasing a new product. While assessing benefits in the use of a new product of technology from consumers' side, debates and conflicts often occur due to different interests and values among individuals and interest groups. In this context, individuals are required to have appropriate ability, attitudes, and competencies in science to reach solutions.

Methodology of Research

Participants

The study was carried out in a 10th-grade science extracurricular activity class in two different schools, a general high school and a science high school. Each class of two high schools was composed of 15 students. Therefore, the students participated in the study are 30 in age of 16 including 9 females and 21 males. In each science class of two schools, two science teachers implemented a nanotechnology related SSI program for three periods of 100 minutes block time in 2014 after regular classroom hours. Students participated in learning activities of the program as a group of five students.

Nanotechnology related SSI program

The program for the study was modified from the original program developed by Muskin et al. (2010), which consists of three parts: investigating products; testing nanoparticles; and debating societal implications. The researchers in this study redesigned instructional strategies in order to include key competencies explicitly.

Key competencies included in the program are: Part 1: investigating products focuses the competency using tools interactively. It involves 1) identify, locate and access appropriate information sources by allowing students to search nanotechnology products from internet database; 2) recognize and determine what is not known by guiding stu-

dents to work with Need-to-Know Board of problem-based learning model. During this part, students were asked to identify and research products that use silver nanoparticles including a particular washing machine. After gathering information from websites, they prepare a two- or three minute introductory presentation to the whole class and discover that the silver nanoparticles are used as antimicrobial agents in various products.

For Part 2: testing nanoparticles focuses the competency required for scientific literacy by PISA. It involves the competency of designing scientific enquiry, and interpreting data and evidence scientifically by allowing students to test effectiveness of silver nanoparticles as antimicrobial agents. Students question whether silver nanoparticles are truly effective as antimicrobial agents and inquire how these claims might be investigated. Basic concepts of microbiology are introduced in real life contexts and experimental techniques to test the bacterial sensitivity to silver nanoparticles are demonstrated. Students have opportunity to have in-depth discussion about valid experimental designs.

For Part 3: debating societal implication emphasizes the competency interacting in heterogeneous groups. It involves mainly on the ability to manage and resolve conflicts by allowing students to prioritize needs and goals, deciding what they are willing to give up under what circumstances. For instructional strategies of this part, a role-playing debate and jigsaw model were adopted. The scenario for the role-playing debate featured a hospital that was considering the purchase of washing machines using silver nanoparticles. Students in a group were given one of five roles: health care workers, patients, hospital purchasing manager, hospital legal counsel, and environmental regulator. At the end of activity, each group of students presents a recommendation based on information and arguments.

Data Collection and Analysis

To investigate the effectiveness of the program on competencies of students, pre- and posttests of survey instruments and in-depth semi-structured interview were administered in lines connected to key competencies in science as well in general. Quantitative data of instruments of 5 Likert-scale items were statistically compared before and after the program. Qualitative data were collected after program and interview contents with individual students were transcribed.

Results of Research

It was found that there were significant ($p<.05$) increases in competencies of self-management ability and knowledge and information processing ability ($t = -3.934$), inquiry ability in science and scientific problem solving ability ($t= -2.962$). However, there is no significant increase in competencies of communication ability and ability to work collaboratively in community. Results from semi-structured interview revealed effectiveness of the program. Students developed awareness of different perspectives and potential bias. Students also realized that evidence is needed to support their claims, and that their decisions contain elements of positive and negative as conflicting impacts.

Conclusions and Implications

Attempt to develop competencies in science through implementation of a nano-technology related SSI program showed some implications. It is important to include a real life context and inquiry oriented activity. It also implies that instructional strategies can function as a parameter of effectiveness in developing different competencies.

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VERKHOVSKY EPONYMS IN THE EPOCH OF EDUCATIONAL ETHNOCENTRISM

Uladzimir Slabin
University of Oregon, Eugene, USA
E-mail: uslabin@uoregon.edu

Abstract

Being of didactic and axiological potential, eponyms are important for science education, in particular for implementing the principles of humanization and historicism. Reviewing literature for dictionary of chemical eponyms, an unusual publication on teaching chemistry was found. It contained a number of self-introduced eponyms, no one of them is in use nowadays. Implications of the time the book was published at, ethnocentrism in education are discussed.
Keywords: *chemical eponyms, laboratory equipment, chemistry teaching, Verkhovsky, ethnocentrism.*

Introduction

Eponyms (terms that contain the names of the phenomenon's, law's, constant's, etc. discoverer) are abundant in mathematics, physics, chemistry, biology, geography and many other natural sciences. In this paper, non-possessive eponym forms are used as recommended (Cheng, 2009) because the person or locale behind the eponym has no actual proprietary claim on the entity. Eponyms have important didactic and axiological potential, and hence can and should be utilized in science education in many roles including as vehicles of principles of humanization and historicism.

Reviewing literature for a dictionary of chemical eponyms, 106 sources in Belarusian, English, Latvian, and Russian languages were looked through and 1642 eponyms were identified including named acids, adapters, apparatus, bases, catalysts, condensers, constants, elements, equations, filters, flasks, formulas, funnels, intermediates, laws, principles, projections, pumps, reactions, rearrangements, salts, stoppers, theorems, theories, vessels, asf. (Slabin, 1995).

Among the reviewed sources, one focusing on teaching chemistry looked unusual (Verkhovsky, 1959): it mentioned six eponyms named by the author of the book. The author is an outstanding authority for teacher communities in the post-USSR countries. "He himself invented, developed, advanced and checked a number of experiments and devices. Some of them saved his name in theirs" (Teleshov & Teleshova, 2013). So this analysis is not to question Verkhovsky's authority, but to check current usage and longevity of his eponyms.

Methodology of Research

Analysis of the book in question and Internet search for Verkhovsky eponyms verbatim in Russian and English, using such services as Google Scholar, Google Books,

databases EBSCO, Academic Search Premier, Web of Science, eLibrary.ru and others were used.

Results of Research

The book (Verkhovsky, 1959) mentions six eponyms and contains images of five of them: Verkhovsky buret (Rus. бюретка, p. 306), Verkhovsky burner (Rus. горелка, p. 158), Verkhovsky clamp (Rus. зажим, p.373), Verkhovsky eudiometer (Rus. эвдиометр, p.337), Verkhovsky ozonator (Rus. озонатор, mentioned in the page next to eudiometer, but not described), Verkhovsky stand (Rus. штатив, p.342).

The Internet search revealed the following eponym occurrences:

1. Verkhovsky buret (Rus. бюретка) – 2, same text in the following context: "Sure enough, these are not all chemical devices. In our article, we did not mention Davy lamp, Renault pycnometer, Verkhovsky buret…" (Kutumov & Teleshov, 2001);
2. Verkhovsky burner (Rus. горелка) – 2, same text (Stepin, 1999);
3. Verkhovsky clamp (Rus. зажим) – 1 (Goriachkin, 1953);
4. Verkhovsky eudiometer (Rus. эвдиометр) – 6, including (Fadeev & Zlotnikov, 1999) and (Teleshov et al., 2013);
5. Verkhovsky ozonator (Rus. озонатор) – 6, including (Fadeev et al., 1999) and (Teleshov et al., 2013);
6. Verkhovsky stand (Rus. штатив) – 10, including (Fadeev et al., 1999) and (Teleshov et al., 2013).

Besides those mentioned in the book (Verkhovsky, 1959), there are also:

7. Sozonov – Verkhovsky test tube (Rus. пробирка) – 6. Along with (Fadeev et al., 1999) and (Teleshov et al., 2013), those include an Internet-shop where one can buy the test tube.
8. Verkhovsky apparatus (Rus. аппарат) – 6. Five of the sources contain the same text.

All the above findings relate to the queries entered into Google in Russian. As for those typed in English, even in multiple versions with respect to variability in using possessive case and transcription from Cyrillic script (Verkhovsky, Verkhovski, Verkhovsky's, Verkhovski's), no traces of the eponyms were found. Moreover, there appears only one page where the scientist himself is described in English (Russian Information Network, n.d.).

Conclusions

Verkhovsky eponyms do not occur in modern Internet publications as applied to current laboratory practice or teaching chemistry. They are sometimes mentioned in Russian segment of the Internet as a historic legacy of the great Soviet chemist. Formation and rise of eponyms from local and situational usage to the sustained world popularity involves a number of factors, and the discoverer's real merit is merely one of them. The reason why so many eponyms could originate from one author and be self-introduced in his book can be assigned to ethnocentrism. This trend emerged in nineteenth century to confront universal nature of science education, it is still notable in Europe (Szabolcsi,

1899) and was especially strong at early Soviet history. Despite Verkhovsky eponyms being historic, local and relative, they could and should be effectively used in chemical education in Russia for the sake of humanization.

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PRE-LEARNING ACTIVITIES USING A TEXTBOOK: A CROATIAN VIEW

Snježana Smerdel
University of Split, Croatia
E-mail: ssmerdel@gmail.com

Meliha Zejnilagić-Hajrić
University of Sarajevo, Bosnia and Herzegovina
E-mail: mzejnilagic@pmf.unsa.ba

Abstract

A pilot research was carried out on a sample of teachers in order to determine the frequency of textbook usage within the pre-learning strategy for teaching chemistry and biology in primary and secondary schools. Data were collected through a questionnaire, and processed with descriptive and inferential statistics. Teachers use a textbook with written materials, as well as online resources within the frame of the pre-learning strategy quite rarely, and there is no difference in textbook usage regarding the education level.
Keywords: *cognitive load, pre-learning activities, using a textbook, working memory capacity*.

Introduction

There are topics in teaching chemistry and biology that the students have the most difficulties learning. The main reasons are the very nature of the science, learning methods (Johnstone, 1984), as well as a limited working memory capacity (Johnstone, 1989). According to the Cognitive Load Theory (CLT) (Sweller, 1988), information processing and knowledge building are limited with the working memory capacity. The overloaded capacity does not leave space for thinking and organization, which results in cognitive overload, whereby mislearning, or no learning at all takes place (Johnstone, 1989). Increasing the level of pre-knowledge by using pre-lecture resources within the frame of the pre-learning strategy leads to efficient connecting of new information with the existing knowledge, as well as reducing working memory overload. Pre-lecture resources are any activities a student might do in preparation for the lecture. This could take a form of reading a textbook extract or Word document, listening to a podcast, performing an online activity, or completing a quiz. The key aspect is that the pre-lecture activity is integrated into the module design and into the lecture itself, so that it has an attributed sense of value by the student and teacher (Seery, 2010).

The preparation of students for the lecture should include, as a minimum, reading of a corresponding material in the textbook. Significant researches indicate the advantages of learning through reading before the class, and using productive reading strategies which have specific and clear goals outlined (Seery, 2012). In Kristine's research (1985), students were asked to read a section of a textbook prior to the lecture, and were asked questions at the start of the lecture. Collard, Girardot and Deutsch (2002) argues that

engagement with the textbook and online assignment in teaching chemistry results in more active learning. Results of implementation of pre-reading assignments with an associated online quiz show that students recognize positive effects of pre-readings, such as preparation for class (Heiner, Banet & Wieman, 2014).

In the Croatian education system, there is no relevant research which refers to the importance of using pre-learning activities with the goal to reduce students' cognitive overload. In this work, a pilot research is carried out to determine the frequency of using textbooks within the pre-learning strategy for teaching chemistry and biology. The following hypotheses are proposed:

H_1: Chemistry and biology teachers in primary and secondary schools use a textbook with written materials within the frame of the pre-learning strategy quite rarely.

H_2: Chemistry and biology teachers in primary and secondary schools use a textbook with online resources (quiz, discussion) within the frame of the pre-learning strategy quite rarely.

H_3: There is no significant difference is using a textbook with written materials for teaching chemistry and biology in primary and secondary schools.

H_4: There is no significant difference is using a textbook with online resources for teaching chemistry and biology in primary and secondary schools.

Methodology of Research

Participants were chemistry and biology teachers in primary and secondary schools (N = 19) in one of the twenty Croatian regions. The conducted pilot research is the first stage of a more comprehensive research regarding the implementation of the pre-learning strategy into the natural sciences education. A questionnaire with 27 multiple choice claims was created for the purpose of the entire research, and this pilot research used the part of the questionnaire with five claims which required from the participants to estimate the frequency of textbook usage within the frame of the pre-learning strategy. The questionnaire was distributed online to chemistry and biology teachers from the entire region in spring 2017. Based on the set research hypotheses, the collected data were analysed with descriptive statistics (answer frequency) and inferential statistics (two-tailed non-parametric Mann-Whitney U-test) of the SPSS software.

Results of Research

The frequency of teachers' responses for data collected through the questionnaire on the entire sample was expressed in percentages, and shown in the chart in Figure 1.

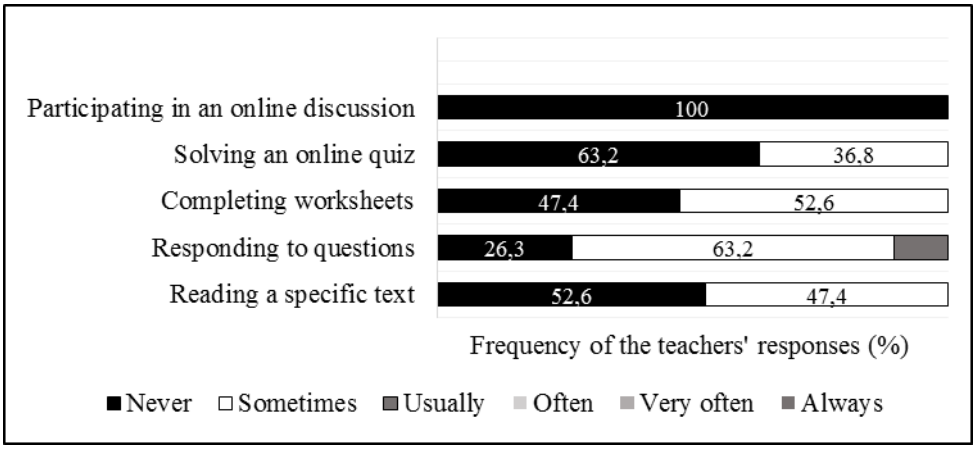

Figure 1: The percentage of teachers' responses for claims of the questionnaire "The frequency of textbook usage within the frame of pre-learning strategy" (N = 19).

Throughout the entire questionnaire, the highest response frequency is for never, sometimes and usually, whereas other offered responses do not appear at all. Such findings indicate very poor usage of textbooks with written materials and online resources within the frame of the pre-learning strategy in teaching chemistry and biology which corresponds to the claims of the H_1 and H_2 hypotheses. Therefore, they are accepted.

For evaluation of differences in the teachers' responses regarding the level of teaching, the two-tailed non-parametric Mann-Whitney U-test was used for two independent groups: group 1 – primary school (N = 10) and group 2 – secondary school (N = 9). The test results clearly show there is no statistically significant difference (U = 112.0, N_1 = 10, N_2 = 9, p = 0.281, two-tailed) in using textbooks with written materials for teaching chemistry and biology in primary and secondary schools, which corresponds to the claim of the null hypothesis. Therefore, the H_3 hypothesis is accepted at the level of significance $\alpha = 0.05$. Likewise, the test results show there is no statistically significant difference (U = 141.0, N_1 = 10, N_2 = 9, p = 0.932, two-tailed) in using textbooks with online resources for teaching chemistry and biology in primary and secondary schools, which corresponds to the claim of the null hypothesis. Therefore, the H_4 hypothesis is accepted at the level of significance $\alpha = 0.05$.

Conclusions and Implications

According to the research results, it can be concluded that the pre-learning activities with textbooks and written materials, as well as textbooks and online resources are used at a negligible measure for teaching chemistry and biology in primary and secondary schools, and that there are no differences regarding the education level.

Some earlier research findings showed that pre-lecture assignments encourage students to have an in-class discussion, and improve their understanding of the teaching material, which indicates that using a textbook as a pre-learning activity has its place in class. In order to encourage students to reading, information processing and critical

reasoning about the material prior to attending the class, it is necessary to use productive reading strategies which have specific and clear goals outlined.

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EDUCATION IN THE AREA OF NEW NEW MEDIA ON THE EXAMPLE OF YOUTUBE AND INTERDISCIPLINARY WORKSHOPS

Renata Stasko, Karolina Czerwiec, Katarzyna Potyrala, Emanuel Studnicki, Anna Michniewska
Pedagogical University of Cracow, Poland
E-mail: rstasko@up.krakow.pl, potyrala2@wp.pl, karolinaczerwiec@gmail.com, emanuel@up.krakow.pl

Abstract

The aim of the research concerning the organization of interdisciplinary educational workshops for 50 students-future teachers of technics and informatics. It was important to raise their level of social, communications and media competences, as well as the diagnosis of their attitudes towards the possibility of improving their technical skills of using new new media, in particular YouTube service. Results of the research show that the workshops allow students not only to develop their scientific thinking during the manual-technical and communication actions at the university, but also percept of the need to organize such activities in order to shape an appropriate approach to contemporary scientific and communication problems.
Keywords: *media education, interdisciplinarity, digital competences, workshops, YouTube*.

Introduction

New media are fixed elements of the virtual world in which the consumer of information is at the same time its producer. Importantly, the sender of the information does not need to be a specialist in the field; just as a commentator for specific content does not have to be a professional. Reading and writing skills are sufficient to post videos on YouTube, post on Twitter and Facebook, or blog on any topic you choose. New new media are very influential opinion-forming mediums. YouTube is also one of the causes of the revolution in popular culture (Levinson, 2013; Cave Henricks & Shelton, 2016). It is therefore appropriate to introduce "education to virtual life" (including "protection education" that teaches online behaviour and "creative education" for creative use of the media) into school education and treat it as an "education field" in media education, verbal and audio media message, interpersonal relationships between users, experiencing responsibility for one's and others' statements, acting as a mediator, obeying the legal and ethical principles of communication, acquiring theoretical and practical knowledge of the media, gaining awareness of anonymity and privacy on the Internet (Popiel, 2014). One of the challenges of modern education is also the launch of pedagogical and educational activities in the field of online resources and services, as young people are turning to the virtual environment every day and are very active in the field of online content creation (White, 2012).

The objectives of the research were: 1) to analyse the curricula of the "Technical and Computer Education" course in terms of the range of digital competences that a

student should have after his / her studies; 2 / to identify the range of knowledge and attitudes of students in the teaching profession to improve digital literacy in new new media and to use it in the educational process (e.g. at interdisciplinary workshops); 3 / improving digital competence in the use of computer programs for making instructional videos (tutorials).

Methodology of Research

Research methods and tools are presented in Table 1.

Table 1. Research methods and tools.

Research methods	Research tools
Analysis of documents	An authorial guide to document analysis
Pedagogical experiment (study of attitudes)	Pre-test and post-test (Thurstone attitude scale)
Observation	Observation sheet
Partially-controlled interview	Interview questionnaire
Quantitative analysis methods	McNemar Chi-square test

In the context of education in the field of didactics of technology and computer science it is important to diagnose the extent of knowledge and attitudes of students towards the use of new new media (primarily YouTube) during interdisciplinary craft workshops. The research concept justifies the fact that when analysing the preparation of students-future teachers for education in a given scientific field one must take into account the degree of their preparation for the introduction of the curriculum based on the ability to move in the world of new media and new new media. It was considered as the most appropriate to carry out this pedagogical experiment using Thurstone's attitude scale. One of the stages of this phase of research was to organize workshops on handicraft for students in the field of technical and informational education and to use the tutorials provided on the website of YouTube and to make their own instructional videos using, among other things, computer programs such as ActivePresenter, FreeMind, and HotPotatoes. Pre- and post-test examination were held before and after the workshop. Pre- and post-tests were filled by 50 students of the "Technical and Information Education" of the Pedagogical University of Cracow, teaching course, the first and second degree (1st degree – 3rd year, 2nd degree - 2nd year) in the years 2015-2017. The pre- and post-test included two thematic modules: students' knowledge of new new media and educational aids and attitudes towards new new media. In the data analysis, they were marked in turn: W1-W20, P1-P20.The level of α was calculated, for $\alpha < 0.05$ the response rate of students in pre- and post-test differs significantly. For analysis of the pre- and post-test results, McNemara Chi-square test was used. The results of the study were also supplemented during the workshops by means of pedagogical observation conducted through the subject educator and partially-controlled interviews, during which students were constantly reporting their attitudes towards using YouTube in educational activities and the role of new new media in the contemporary education process at every stage of education.

Results of Research

Significant change (level "p" is lower than border level α = 0,05) in student attitudes had taken place in relation to: digital literacy education, education in the preparation and publication of educational films on YouTube, computer programs used for the preparation and conducting of educational activities, respect copyright of YouTube video creators, vloggers, use of educational videos posted on YouTube, making an instructional video in ActivePresenter and multimedia mental map in FreeMind, promoting new new media in educational institutions and the media.

Post-test results showed, among other things, that:

- ✓ 74% of respondents who in pre-test disagreed with the statement that in the educational institutions and the media there should appear campaigns to identify all functions of new new media based on substantive grounds, in post-test changed their opinions. During the observation and partially-controlled interview, the students expressed the view that there was lack of lessons (mainly Information Technology) in the course of their school experience, in which the content of practical use of new new media in the implementation of individual lesson topics would appear. Students found that "we all lost so much because instead of teaching us, for example, about the practical, educational use of YouTube, teachers most often said that the use of such services is a waste of time; perhaps they claimed this because they had no idea about its educational uses. "That was why students strongly supported the idea of creating a campaign to "change the low opinion about tools like YouTube or other similar services".
- ✓ 30% of the respondents in the post-test found that young people mostly derive the negative stereotypes that appear on YouTube because of their visual appeal, although they disagreed in the pre-test. The interview showed that students blamed the school for such a state of affairs on school curricula and lack of social knowledge (including teachers) on the full range of opportunities offered by YouTube. If the knowledge transfer was based on a fully substantive basis, then "young people would not only see the entertainment and visual side of this type of service."
- ✓ 32% of students have changed their attitude to agreeing that online videos are one of the decisive elements of the Internet culture, and that training in the preparation and publication of educational videos on YouTube is an important part of developing digital literacy in the community. According to the students, "Teachers of every subject should use what the Internet offers and make students aware of what types of films they can find there" and
- ✓ post-test showed that 60% of respondents have increased their knowledge of electronic media and ethical communication and have changed their opinions about the nature of YouTube's educational and information entertainment. Students found that handicraft workshops made them aware that they could use YouTube during their teacher training. In their view, this will be one of the best ways to educate students about the benefits and risks of using the Internet.

Conclusions

Correlation analysis of the variables tested showed significant correlations: there was a correlation between respondents' opinions on attitude towards new new media in the pre- and post-test; there is a correlation between the respondents' opinions about the knowledge of new new media and the programs supporting education included in the pre- and post-test.

Interdisciplinary workshops on handicraft based on the use of new media (e.g. YouTube) allow multi-faceted development of hard and soft teacher competencies among students.

Modern science and modern technological challenges generate the need for interdisciplinary teaching and the education of students - future teachers in new new media, the development of new value systems for their use and the opportunities to use them in school practice based on substantive grounds, improving social competence, correct information processing from the Internet, creativity, teamwork, and learning beyond the curriculum.

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LOCATING EVIDENCES OF EDUCATION FOR SUSTAINABLE DEVELOPMENT IN SUB-SAHARAN AFRICAN SCIENCE AND TECHNOLOGY EDUCATION CURRICULAR: A COMPARATIVE ANALYSIS OF NIGERIAN AND SOUTH AFRICA

Alvin U. Ugwu
University of KwaZulu-Natal Durban, South Africa
E-mail: vinyjnr@gmail.com

Abstract

This research explores the integration of Education for Sustainable Development in the Science and Technology School Curriculum Documents of the Sub-Saharan African giant nations (Nigeria and South Africa) through a comparative analysis. The paper supports that Sustainable Development is a key in a present-day Science and Technology school curricula, given the global economic, social, cultural and environmental imperatives. The study suggests that science and technology curriculum should be a critical transformative tool towards integrating and fostering Sustainable Development in developing countries.
Keywords: *education for sustainable development, sustainable development, Sub-Saharan Africa*.

Introduction

The (United Nations [UN], 1993) Rio de Janeiro Earth summit declaration (Agenda 21) is "a program of action for sustainable development worldwide and a comprehensive blueprint for action to be taken globally into the twenty-first century by Governments and non-governmental organizations, in every area in which human activity impacts on the environment" (p. 3). Hence Agenda 21 emphasized on the interconnectedness of the three dimensions (Society, Economy and Environment) of sustainable development (United Nation's World Economic and Social Survey [UNWESS], 2013). Furthermore, the United Nations 2005 to 2014 'Decade of Education for Sustainable Development' (UNESCO DESD, 2007) did not leave African Nations out of the idea to evaluate what had been achieved through education since the declaration of plans towards achieving Sustainable Development (SD). Rather, much attention needs to be paid towards developing countries including in Africa, if sustainability is a global goal. In this study, it was analysed the weaknesses and strengths of the South African and Nigerian intermediate phase Science and Technology curriculum, in functioning as instruments to actualizing Sustainable Development in these two contexts.

However, the study considered the inevitable nature of curriculum reforms that have occurred in the various educational systems especially in the post-colonial era, in a bid to create a worthwhile structure of teaching and learning content areas and pedagogy. Similarly, curriculum reforms depict pursuit for societal objectives such as knowledge, skills and values intended to impart on the learners, and to support inclusivity. Presently, South African Curriculum and Assessment Policy Statement (CAPS), was officially implemented in 2012. In the CAPS, intermediate phase curriculum, Natural Science and Technology are integrated into a single learning area. On the other hand, the Nigerian education system likewise South African, also experienced post-colonial curriculum reforms. The current National Policy on Education advocates for an inclusive education system which aims at achieving Millennium Development Goals (MDGs). In the Nigerian Junior Secondary School Level Basic Science and Basic Technology are offered in two separate learning areas.

Literature Review

In most developing countries, Insufficient food and water and lack of other basic amenities; population explosion are socio-economic challenges are eminent (UN WESS, 2013). South Africa is presently facing a huge challenge of unsustainability or lack of food, water, energy, and other socio-economic crises (Bormann & Gulati, 2014). Similarly, Oyedepo (2012), suggest that an alarming degree of the Nigerian population does not have access to electricity, food and water because of overpopulation, corruption and unsustainability. On the other hand, Jasper (2008) argues that in the past couple of decades have witnessed amazing rate of technological boom which perhaps creates environmental and economic concern, regardless of the context. Education for Sustainable Development involves inner transformations on the part of the major target groups such as young children in schools and teachers (Jaspar, 2008). The UNESCO (2012), suggests that sustainability can be achieved by making primary, secondary school teachers and school policy makers the target audiences.

In understanding the critical nature of the need for Sustainability in Science and Technology Education, we must embrace a paradigm shift towards "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (UNESCO, 2012, p. 5), Hence the emphasis lies on maintaining a balance between the three spheres (Society, Economy and Environment) and improving the quality of life (UNESCO, 2012).

South Africa as a nation has taken a great stance on Sustainable Development through its vision as it ''aspires to be a sustainable, economically prosperous and self-reliant nation by meeting the fundamental human needs of its people, by managing its limited ecological resources responsibly for current and future generations'' (Department of Environmental Affairs [DEA], 2008, p. 8). This vision is critical as most developing countries currently face huge ecological resource depletion. Nigeria as a nation has a distinct culture and diversity, hence the nature of education in Nigeria is relative to its historical and political evolution. The National Policy on Education (2013) aims at creating a holistic structure of education in Nigeria that accounts for all aspects of national development, through frequent review of the curriculum, to accommodate all the sociopolitical changes. The Nigerian nation proposes to address the issue of sustainable

development through its schooling curriculum policies. ‘‘School curriculum has been diversified to include courses that are predisposing to development issues’’ (Osuji, 2004, cited in Nnabuo & Anosike, 2012, p. 7). As a third world nation, Nigeria has complex environmental issues and unstainable practices. Therefore, the Science and Technology school curriculum can be used to address issues of the environment through environmental education and issues that pertain the society through education for sustainable development.

Educators have a call through the curriculum and classroom practices to train and produce learners/students who are creative thinkers and problem solvers. ‘‘The emerging global sustainability crisis demands an educational response that moves beyond mere ‘tinkering’ with classroom practices, towards technology education which embraces life cycle thinking and eco-innovation’’ (Elshof, 2008, p. 133). Modern Science and Technology education in developing countries must aim at equipping learners/students with opportunities to develop critical skills, knowledge, and attitude that will enable them to solve problems in their societies (Standards for technology literacy, 2000). There is therefore the need for consistent curriculum reforms to synchronize all aspects of the ever-changing society.

Methodology of Research

The research adopted a qualitative case study approach and uses a hermeneutic research design, which aim to understand and interpret phenomenon in an objective manner, by investigating a real-life context and generating empirical data from a range of different evidences or cases (Gilham 2000, Yin 2003, cited in Denzin & Lincoln 2004). Hermeneutics is applied to interpret written documents, events, situations and human practices (Crotty, 1998, cited in Zweck, Paterson and Pentland 2008). The curriculum documents were analyzed as the qualitative data source by relating the goals, philosophies, content coverage, recommended learning materials, tasks and activities to the UNESCO (2015) Agenda 2030 SD goals to make sense of the weaknesses and strengths. The focus on the intermediate phase Science and Technology curricular is because it is believed that the intermediate phase of the curriculum should offer learners/students with the basics of Science and Technology in schools. Hence, it was determined to investigate if ESD is integrated in the South African and Nigerian intermediate phase Science and Technology curricular and to understand what might have informed the integration or not. These two contexts (Countries) share similarities in various spheres of SD, especially in terms of Economy and Gross Domestic Product (GDP), Education, and sociocultural dynamics (Cilliers, Schünemann & Moyer, 2015). The knowledge of the above inquiry would enable a valuable contribution towards the current discusses on ESD in Africa.

Result of Research

The analysis revealed both examined contexts demonstrated awareness Sustainable Development (SD) goals in the intermediate Phase Science and Technology curriculum. Evidences of integration of ESD was deduced looking at the philosophy, content and topic sequence and SKVA. The South African CAPS curriculum through its

philosophy, proposed of actualizing some of the SD goals in several instances such as; "this curriculum aims to ensure that children acquire and apply knowledge and skills in ways that are meaningful to their own lives by promoting knowledge in local contexts, while being sensitive to global imperatives" (DBE, 2011, p. 4). Equally, the underlying philosophies of the Nigerian curriculum show sensitivity to basic literacy and numeracy in Science and Technology Curriculum.

Conclusions and Implication

The changing society calls for innovative teaching and learning strategy in Science and Technology education. Learners at the intermediate phase show optimum enthusiasm in knowledge development, hence imbibing the culture of Sustainability should be a natural flow of knowledge than hassle. Problem-based learning is recommended to uncover the natural creativity in children. ESD must be perceived as a transformative measure in Science and Technology curriculum as it plays a fundamental role in creating the moral values required to actualize sustainability in the society. Integration of Science and Technology subjects with social studies is also recommended for better comprehension of the concepts of SD. However, the political nature of school systems in Africa has always jeopardized the education and redefined the purposes of teaching profession.

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DISCIPLINE IN SCHOOLS: SOME ACTUAL ISSUES

Alex Wirth, Boris Aberšek
University of Maribor, Slovenia
E-mail: alex.wirth@student.um.si, boris.abersek@um.si

Abstract

Discipline in class is essential. Without it the educational processes and teachings are difficult. In this manner curricula goals are almost impossible to achieve. There are and there always will be some kind of conflicts between teachers and students, but they should not evolve to become a problem. Teachers (especially elderly teachers) often express pessimism of contemporary students. They say that today's students have less knowledge, they do misbehave more often than previous generations.
A study among students was conducted. It was trying to determine the rate of discipline in schools in Celje to see if these statements are true. The questionnaire to students of one primary and one high school in Celje, Slovenia were distributed. The answers from 234 students were received. On the one hand, it was found out that senior high school students have the worst level of discipline of all the grades tested. They themselves assess their class atmosphere as less disciplined. They report that teachers use a lot of time to calm the class down. All this is probably a factor in lower average grade that the senior high school students have. On the other hand, it was found out that teachers do not react to the disturbance or they are trying to be repressive. These are not the correct ways of dealing with discipline issues. Therefore, there are some recommended ways how teachers should react.
Keywords: *discipline in class, primary school, contemporary student, elderly teachers*.

Introduction

In the past it was fairly easy for teachers to resolve discipline problems by, for example administering a corporal punishment. For a long time, it was socially acceptable that teachers could spark a child. A corporal punishment was considered as a part of education. One of the biggest milestones in this field was Convention on the Rights of the Child (General Assembly UN, 1989) which defined a child as a person with human dignity. Childhood was marked as privileged and protected life period. A child got the right to voice his opinion. In terms of discipline the Convention on the Rights of the Child sets that discipline in schools has to be enforced in a way that respects human dignity. Not only this means that you cannot use corporal punishment, but when restoring discipline you have to consider the human dignity of a child (Pšunder, 2004).

Many teachers encounter discipline problems during their work in the classroom. It is somehow expected that conflicts and problems occur between students and teachers. According to Slovene literary language dictionary (Institute for Slovene Language, 2016) conflict is spiritual state of helplessness because of contradicting interests. Rebellious nature of youngsters searching their identity often results in the misbehaving in the classes. They interrupt efficiency of a group or individual work with their behavior

(Wirth, 2016). If there are too many such distractions in the classroom, the discipline problem emerges.

Conventional discipline methods for restoring order in the classroom that are available to teachers have drawbacks. These methods are: lectures (preaching), threats, rewards, punishment, comparison, anger, criticism, corporal punishment (no longer permitted), commands, note to parents, sending the child to principal's office (Koenig, 2008).

A disciplinary climate is positively related to student performance (OECD, 2013) therefore at least some level of discipline should be demanded in class. The orderly environment helps students' performance and weakens the impact of students' socio-economic status on performance. Fortunately a PISA survey (OECD, 2010) found out that most students from participating countries enjoy order in the classrooms.

Methodology of Research

The questionnaire was used as a tool of our research. A questionnaire has to be reliable, applicable and objective (Fraenkel, Wallen, 2012). In the analysis, established matrices were needed for the measurement of parameters that were gathered with the questionnaire. The individuals who conduct a study must not affect the results of the analysis. The repeated study with the same questionnaire and the same sample must yield the same results.

An anonymous study was allowed to conduct among students of one primary school (student age from 6 to 14) and one high school (student age from 15 to 18) in Celje, Slovenia. The questionnaire was distributed to the students to acquire their answer. Despite the sample is too small to be representative and the study results cannot be generalized to the whole population it shows some tendencies in the level of discipline in our schools. Because of the small, but random sample descriptive statistics is used for the analysis.

Results of Research

The open answers, though hard to evaluate, give us interesting insight into the core of the conflicts. Students that answered that they do not obey every teacher equally established that they do so because some teachers demand less of them or they do not do anything about their misbehavior. Students that stated that they do chat during class without teacher's permission explained that they do so if the subject is easy. When asked how their teacher reacts when class is disturbed students told us that teachers do not react to the disturbance in class or they are trying to be repressive. Students wrote that some teachers are yelling at them, calling them names, logging unjustified absence from the class to the troublesome students, sending them out of the classroom… These are signs of teacher's lack of authority.

Teachers should not enforce discipline by conventional disciplinary methods because they may have opposite effect. The punished student often does not understand his/her faults and regards the punishment as his failure and handicap. Instead, as Gossen and Amstutz recommend, teachers should use restitution. Restitution means to correct wrongdoing or damage. Biblical principle "an eye for an eye" does not provide a positive

effect either. Restitution gives the victim a proper compensation and the perpetrator a way to repent himself in the different ways. In that way restitution tries to inhibit further mistakes and misbehavior (Gossen, 1993) (Stutzman Amstutz, 2005).

Because the conventional ways of restoring discipline are flawed the Koenig proposed strategies for minor misbehaviors and strategies for difficult misbehaviors. Strategies for minor misbehaviors are: use friendly evil eye, invade space, touch shoulder, whisper technique, smile and request, allow thinking time, change locations, exercise the quiet signal, state your request, give information, convey qualities plus expectations, give choices, respect the struggle, answer questions with questions, do research. Strategies for difficult misbehaviors are: write a note, express strong feelings, arrange mini-counseling session, schedule cooperative planning session, chart behavior and consequences, use time-out, change volume and tempo, encourage student involvement, build relationships, use activities for leverage, analyze and plan, inform parents, give responsibilities, plan for amends, deliver "I" messages, assign student essay, form a small discipline support group, consult with principal and counselor, schedule a meeting with the principal, counselor, parents, student and yourself (Koenig, 2008).

Conclusions

Schools where the study was conducted have disciplinary problems. The results cannot be generalized due to a small sample but based on our experience one can expect similar results in most schools. In the western world, it is hard to imagine a school that has absolutely no discipline problems. Students know their teachers and their boundaries and act upon them. Very few students admitted that they are the ones who create the disturbances in the class. It might be expected because most humans cannot admit that they themselves are the cause of the problem.

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GROUP WORK IN EVALUATION OF PRIMARY SCHOOL STUDENTS' KNOWLEDGE ABOUT CARBOHYDRATES

Meliha Zejnilagić-Hajrić, Adel Polutak, Ines Nuić
University of Sarajevo, Bosnia and Herzegovina
E-mail: mzejnilagic@pmf.unsa.ba

Abstract

In this research two different ways of students' reviewing their knowledge in chemistry about carbohydrates are described: group work and discussion with teacher. In experimental group (EG) students were working in groups on their assignments, while in control group (CG) discussion led by teacher was implemented. Results showed better EG students' achievements on paper-and-pencil test of knowledge on the following class.
Keywords: *evaluation, group work, teacher-led discussion, carbohydrates*.

Introduction

Group work showed certain benefits when applied in the classroom, such as improved individual achievement of students working in groups compared to students working alone. Group work also promotes problem solving, critical thinking, reasoning abilities and cooperation among students. There is limited research regarding group work application in reviewing course materials and subsequent evaluation of students' academic achievements. Moreover, group work is not applied much often in our primary and secondary chemistry teaching for various, more or less justifiable reasons. The aim of this research was to explore if there are benefits of group work in reviewing chemistry course material in *Carbohydrates* for primary school, comparing to traditional reviewing of the same material with teacher-led classroom discussion.

Methodology of Research

Research design was quasi-experimental. Participants of this research were 9th grade primary school students aged 13-14 years divided in control group (CG, n = 42, two classes) and experimental group (EG, n = 46, two classes). First, test of knowledge was administered in order to establish students' initial knowledge on *Carbohydrates*, along with a Likert-type questionnaire regarding students' opinion on chemistry as a school subject. Then, in control group the review of course material on *Carbohydrates* was implemented with teacher-led discussion in the classroom. In the experimental group the review was implemented using group work where students, divided by their teacher in five groups, were working on their assignments. On the following class-hour another paper-and-pencil test was administered in order to test students' achievements

in both groups. All research instruments were designed for the purpose of this research. Data obtained were analyzed using descriptive statistics parameters and t-test.

Results of Research

Data obtained on the test of initial knowledge on *Carbohydrates* showed slightly higher achievements of EG students (M = 5.74, SD = 2.95) than CG students (M = 5.50, SD = 2.83) but there was no statistically significant difference between students' achievements ($t(85) = .385$, $p > .05$). Maximum score that could be obtained on this test was 20 points; the highest score was10 points in CG and 12 points in EG. Results of the questionnaire showed that these students find chemistry as a school subject interesting (> 70 %) and they mostly (> 75%) grade it with 4 or 5 (5 being the highest grade). However, they do not experience group work very often (10.2 %) but they believe that using group work more often they would find the solution of an assignment more efficiently (64.1 %). Data obtained from the test of knowledge after reviewing course material did show statistically significant difference between groups, in favor of EG ($t(84) = 3.61$, $p < .001$). Maximum score on this test was also set to 20. The highest score of EG students was 20 (M = 14.55, SD = 4.54), for CG 19.5 points (M = 11.1, SD = 4.38). Both groups showed improved achievements on this test compared to their achievement on initial test of knowledge: control group ($t(40) = -13.41$, $p < .001$); experimental group: ($t(45) = -28.1$, $p < .001$).

Conclusions and Implications

This research showed there could be a significant potential of using group work on chemistry classes. Even though there were limitations such as limited time for conducting the research and relatively small number of participants, data confirmed the benefits of group work in reviewing the course material on *Carbohydrates* in primary school chemistry. Results showed that EG students performed significantly better than CG students on the test of knowledge after conducting group work. Both groups showed higher achievements comparing to those on initial test, which confirms the need for reviewing course material after teaching a lesson or a section within course. These promising results can lead to more extensive research regarding the application of group work not only in reviewing the course material but also in other aspects of teaching chemistry at this level.

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