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PROJECT-BASED AND OTHER ACTIVATING STRATEGIES AND ISSUES OF SCIENCE EDUCATION XIX.

BOOK OF ABSTRACTS

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STUDENTS AND TEACHERS PARTICIPATION IN AN AUTHENTIC OUTREACH ACTIVITY WITH THE SCANNING ELECTRON MICROSCOPE: FROM FACE-TO-FACE TO REMOTE MODE

Ron Blonder, Ella Yonai

Abstract

The scanning electron microscope (SEM), which has been made available for scientific research since the early 1960s, is an exciting method for characterizing surfaces (1). SEM has the ability to reach nanoscale resolution, which is about 250 times the magnification of the strongest light microscope. This ability of SEM, together with its versatility, especially regarding contemporary scientific research, makes it of particular interest in science education, because it can be used to introduce contemporary research to students. At the Weizmann Institute of Science, an outreach activity for high-school teachers and students was designed with the goal to expose the participants to authentic research and to real scientists. Since the Covid-19 outbreak, education systems have utilized the remote mode, and outreach activities that usually take place in a research or academic setting have usually been canceled or there has been a search for innovative approaches to shift them to digital space. In the current research, a design-based approach was applied to transform an existing authentic science activity using the SEM from 'face-to-face' (f2f) learning to remote mode. The remote mode activity included remotely operating the SEM by the participants. The goal was to formulate a general approach to transform authentic outreach activities from f2f to remote mode. To evaluate the design, we compared learners' perceived authenticity in the two modes and reflected on the process. The results suggest that some aspects of authenticity related to the experience of learning content have a positive potential for use in remote mode. However, the learners' experience of connecting with the scientists was found to be an apparent disadvantage in remote mode. However, improvements in communication technology and in the pedagogy of remote teaching are a promising direction for improving student-researcher interactions in remote mode of the outreach activity.

Key words: scanning electron microscope, science education, remote education

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PROBLEM-BASED LEARNING IN A CROWDED CURRICULUM: THE LADDER APPROACH

Angela Stott

Abstract

Problem-based learning tends to be interesting for learners and can be a good vehicle for developing 21st Century Skills. However, it can be difficult to implement, particularly within a crowded curriculum with high-stakes examinations, and with weaker or less knowledgeable learners. In this presentation I share a teaching strategy which emerged from a three-year action research study of my own Science teaching using problem-based learning within a crowded curriculum: The Ladder Approach. I explain this strategy and give a few practical examples I have implemented successfully. I also explain this success, drawing on Self-Determination and Cognitive Load Theories. In the Ladder Approach, focus is alternately shifted between direct instruction and engagement in a long-term complex, interesting problem task. These two run parallel to one another like the sides of a ladder and are connected by scaffolding worksheets which guide the learner to apply what they have learnt from recent direct instruction sessions to solve a section of the problem task. These serve as the rungs of the ladder. The learners help one another to climb the ladder as the teacher draws them upward through both direct instruction and interactive engagement.

Key words: problem-based learning, science education, ladder approach

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SINGLE PAPERS & SYMPOIUM ABSTRACTS

ACTIVATING STRATEGIES IN ONLINE TEACHING: A CASE STUDY IN TECHNICAL EDUCATION

Mateja Ploj Virtič, Andrej Šorgo, Kosta Dolenc

Abstract

SARS-CoV-2 has affected all areas across the world, but especially education. Distance education was the only option at the time of complete closure of schools, and because it did not allow the option of blended learning, the authors call it forced distance education. School subjects such as technics and technology, biology, physics, and chemistry, which emphasize hands-on work and inquiry, were the most disadvantaged. Teachers and educators who wanted to conduct active learning activities faced a particular challenge. Without any prior experience or preparation, we planned activities based on our intuition. The case study shows an example of project-based online learning. The didactic concept of group work allowed the students to divide the tasks according to the individual's abilities, taking into account the available computer equipment. One of the students' tasks was to design a creative product, taking into account the established criteria, and to record and report the activities of the group members on an ongoing basis. Assessment was a particular challenge when working on a distance project work. The process of creation was assessed, which was evident from the recorded process and the degree of creativity of the final product.

Key words: distance group work, forced online education, technical education

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ACTIVATION OF PUPILS WITH SPECIAL EDUCATIONAL NEEDS IN THE TEACHING OF CHEMISTRY AT PRIMARY SCHOOL

AKTIVIZACE ŽÁKŮ SE SPECIÁLNÍMI VZDĚLÁVACÍMI POTŘEBAMI VE VÝUCE CHEMIE NA ZÁKLADNÍ ŠKOLE

Markéta Kantorová, Martin Bílek

Abstract

The problems of pupils with special educational needs, such as ADHD, concerns their chronic deficit, which causes various impairments in the skills necessary for learning, behavior and education. This deficit must be accurately described and characterized. Based on the findings of the teacher and in cooperation with the family and the pedagogical-psychological advisory, the relevant case study will be prepared.

In this article we deal with the issue of using case studies of specific pupils with special educational needs (SVP) to create scenarios for inclusive teaching of chemistry in a heterogeneous primary school. An essential principle in creating scenarios is to focus on motivating pupils with SVP and other pupils. For the creation of teaching scenarios, we also used the results of a survey of chemistry teachers, focused on the application of methods and organizational forms of teaching in inclusive education.

The process of activating pupils, depending of whether they are pupils with SVP or not, should first be based on precise pedagogical and psychological diagnostics, and on this basis we can decide the activating teaching methods and iniciate closer cooperation between pupils, teachers, school and family.

Key words: pupil with special educational needs, elementary school, activation

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AQUAPONIC - FROM AN IDEA TO AN EDUCATIONAL CONCEPT

Martin Lindner, Wenzel Chris

Abstract

The idea to making aquaponic a tool for classroom education was implemented at a visit at Boston College in 2014. The implementation started at the University of Halle and was driven in many student projects of Biology teacher students, as well as of students of the program Management of Natural Resources. We also implemented the idea in Spain and planned activities in Egypt.

Furthermore, we tried to find ways for implementing it into everyday school life: the combination of ecological and technical aspects always thrilled us in finding new ways to overcome the concerns and obstacles and designing a convincing STEM project. We also visited the only German aquaponic plant in Berlin and combined the experiences there with or project work in Halle.

Based on the experience made in the last 7 years, this presentation gives an example of a multidisciplinary approach towards the realization of a simple idea. The underlying theoretical concepts, like motivation theory, or interest, as well as design based research methodology are explained by examples of our yearlong practical work.

Key words: STEM Project, aquaponic, design based research

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DEVELOPING TECHNICAL CREATIVITY WITH PROJECT/PROBLEM-BASED LEARNING DURING THE PANDEMIC COVID -19

Kosta Dolenc, Samo Fošnarič, Mateja Ploj Virtič, Andrej Šorgo

Abstract

The lockdown and consequent closure of the University have led to unequal working conditions for both students and staff in areas of study where much emphasis is placed on practical work. In the course Didactics of Science and Technology II, the content of the course was adapted and designed to focus on technical creativity. This was done by introducing problem-based monthly projects instead of prefabricated exercises and products, which compensated for inequalities and limitations among students. The exercises were conducted as asynchronous activities, an active method most desired by the students. The exercises consisted of four monthly projects in which students had to solve real-life problems to meet given requirements and produce the desired product. The acquired solutions and made product was reported and presented at the end of each project. The adapted course evaluation showed that the course's design fully met and even exceeded the students' expectations. They spent significantly more time on the exercises than there were contact hours in the curriculum. Most importantly, these activities evened out inequalities and enabled each individual to successfully complete the commitments.

Key words: science and tehnology, technical creativity, course evalvation, technical education

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DIDACTIC STRATEGIES OF PROJECT-BASED ONLINE LEARNING OF PROSPECTIVE TEACHERS IN THE FIELD OF BIOLOGY AND ECOLOGY

Andrej Šorgo, Kosta Dolenc, Mateja Ploj Virtič

Abstract

The emergence of SARS-CoV-2 measures in 2020 required a rapid transition to online learning. This posed significant and specific challenges to practice-based subjects such as biology, chemistry, physics, technology and engineering, collectively referred to as STE subjects. The problems arise at several levels. The first level was the complete lack of didactics of hands-on and practical laboratories in the inevitably emerging online distance education. And the second problem, even more difficult to solve, was the lack of laboratory equipment and materials at the students' homes. One of the ways to solve this problem was to incorporate virtual tools. By using virtual tools, it is possible to simulate real laboratories, but at the cost of losing the authenticity of laboratory work and practical skills. To avoid this scenario, prospective biology teachers were encouraged to develop their own labs and strategies for hands-on work with elementary and secondary students. Didactic strategies of online project-based learning in biology and ecology are described in which prospective teachers learn by designing a) smartphone-based laboratory exercises, b) project documentation for an outdoor classroom, green roof, insect hotel, and recycling corner, and c) exercises using household appliances. Students created and tested a series of hands-on exercises as well as project plans that can be implemented online by high school students.

Key words: SARS-CoV-2 measures, online remote education, didactic strategies, practical work

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DIGITAL TECHNOLOGIES IN TEACHING AND LEARNING OF PHOTOSYNTHESIS FROM THE TEACHERS' AND STUDENTS' POINT OF VIEW

DIGITÁLNÍ TECHNOLOGIE VE VÝUCE FOTOSYNTÉZY Z POHLEDU STUDENTŮ A UČITELŮ

Renata Ryplová, Jan Pokorný, Matěj Novák, Štěpánka Chmelová, Zbyněk Vácha, Igor Červený

Abstract

Photosynthesis is internationally recognized as one of the critical points of science education. Science educators are therefore looking for modern ways to teach this topic. Among others, the use of digital technologies is believed to increased attractiveness and improve understanding in science education.

This contribution brings the results of the survey done among secondary school students and teachers with the aim to describe their opinion on the use of digital technologies for teaching and learning photosynthesis. The attractiveness of different ways of digital education of photosynthesis as well as practical laboratory and field activities for students was explored. Teachers willingness to use digital technologies for teaching and main problems in teaching and learning of photosynthesis from their point of view were studied. Both, students and teachers as well, considered learning videos to be the most useful digital toll for teaching and learning of photosynthesis. The students prefer field activities describing the role of photosynthesis in natural environment.

Key words: photosynthesis, digital technologies, science education

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DOCUMENTARY SERIES – HOW A HUMAN AFFECTS THE NATURE AROUND HIM

DOKUMENTÁRNÍ SÉRIE – JAK ČLOVĚK OVLIVŇUJE PŘÍRODU KOLEM SEBE

Karolína Kavanová, Valerie Chvojová

Abstract

This project-based learning (PBL) teaching activity is centred around environmental problems that our Earth is currently facing. Our inspiration for this integrated project-based learning teaching plan was the pandemic during which you could see, that the limited air travel has partially alleviated the environmental pollution. This situation gave us an idea that even small positive changes that can be done by anyone could significantly improve the environmental situation. For this project-based learning activity, we created a set of activities that introduce the current environmental problems through environmental documentaries. These documentaries had been chosen in a poll by students beforehand for the screening evening at school. During the activities, students are asked to form their opinions about the environmental issues that will later be used to form short documentaries regarding the environmental issue from their vicinity they care about and the solution they choose for its amelioration. Later, student-made documentaries will be shown in school for other classes, as well as, for the public who will have to pay an entry fee, that will be donated to an environmental organisation chosen by students themselves. This integrated teaching plan aims to raise awareness about the current state of the environment and about the things we can do to protect it. The proposed activities guide students to a deeper understanding regarding the importance of a positive relationship with nature and the possibilities we have to improve the quality of the environment.

Key words: ecology, environment, environmental documentaries, the human influence on nature

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EVALUATING LEARNER-APPROPRIATE EXPLANATIONS OF ACID-BASE REACTIONS IN UPPER SECONDARY SCHOOL

Rita Krebs, Anja Lembens

Abstract

Conflating the three levels of the chemical triangle (Johnstone, 1991) complicates learner comprehension, especially with complex topics such as 'acids' and 'bases'. However, an overall learning goal should be to develop adequate conceptions and to connect the macroscopic with the submicroscopic properties of ‘acids’ and ‘bases’. Based on this, the need arises to use a conceptually coherent teaching model to capture the submicroscopic level in ‘acids’ and ‘bases’. This study is part of a Design-Based Research project that seeks to construct such a teaching model. In several iterations, the Brønsted-Lowry model of 'acids' and 'bases' is adapted for Austrian upper secondary students, tested, and then further developed according to student feedback to form a learning environment (LE). In a first step, Key Ideas derived from the scientific model were developed and then used to form learner-friendly and scientifically adequate explanations of acid-base reactions. These explanations are tested for plausibility and applicability with upper secondary students (N1=7, N2=4, N3~8) using the method of probing acceptance. Preliminary results show that learners respond positively to our introduction of acid-base reactions using the Electron Pushing Formalism and the definition of acids and bases as particles.

Key words: acid-base reactions, design-based research, method of probing acceptance

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EVALUATION OF STUDENTS' WORKLOAD AND OUTCOMES OF AN ON-LINE ELEMENTARY SCIENCE PEDAGOGY COURSE UNIT

Anssi Lindell, Kamilla Komulainen, Anna-Leena Kähkönen, Terhi Mäntylä

Abstract

The European commission defines ECTS credits as the volume of learning based on the defined learning outcomes and their associated workload. One credit corresponds to 25 to 30 hours of student's work. However, workload is just an estimation of the time average learners typically need to complete the learning activities to achieve the defined learning outcomes. Scaling courses and activities with the workload is not a trivial task. We designed a 1 ECTS on-line science pedagogy course unit and tested it with 169 elementary student teachers. The unit consists of 3 sections: Basics of Science in Schools, Basics of Science Pedagogy and Science Teaching and Learning Methods. The unit is an introductory part of 6 ECTS science pedagogy module for pre- and elementary school student teachers. To develop this course unit to increase its outcomes/workload -ratio, we asked the participants to estimate their workload and the usefulness of the topic and content of each activity in the unit. We shall analyze these ideas along with the ratings of the course teachers, the designers of the unit and a student teacher who accomplished the earlier face to face version of the module. By these analyses we shall discuss scaling of on-line learning units compared to other learning environments

Key words: on-line science pedagogy course, workload, elementary student teachers

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FROM THE TAP TO WASTEWATER TREATMENT PLANT

OD KOHOUTKU K ČOV

Kamila Mertlová, Monika Prokšová, Jan Šelepa, Ondřej Vyskočil

Abstract

Environmental issues are still a current global problem that needs to be dealt with. Therefore, this project focuses on one of the problem areas - namely the lack of water in the world. The project is aimed at pupils aged 13-15. The main part of the project takes place in the 8th grade of primary school or the corresponding year of perennial grammar schools. Pupils are motivated into the project through a text, a video, or a discussion with an expert. During the project students carry out various activities, such as measuring their water consumption, discussing their findings and problems, performing an inquiry-based task, visiting a wastewater treatment plant and creating an output from the project. The impact of the project on pupils will be examined through pre-test and post-test and through a motivation questionnaire, which will also be provided before and after the project. Simultaneously with the project in the 8th grade, a mini-project in the 9th grade will also take place. Pupils of this grade also take an excursion to the wastewater treatment plant. Based on this excursion, the aim will be to motivate students to create supporting material, which will be used then by the 8th grade students. The project supports peer learning and work with resources. It aims primarily at affective goals and thus leads students to take responsibility for water management.

Key words: project-based education, peer learning, environmental issues, water, wastewater treatment plant

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HOW CAN PLANTS AFFECT OUR LIVING IN THE TOWN? INQUIRY BASED EDUCATION WITH PROJECT ELEMENTS

JAK MOHOU ROSTLINY OVLIVNIT NÁŠ ŽIVOT VE MĚSTĚ? BADATELSKY ORIENTOVANÁ VÝUKA S PROJEKTOVÝMI PRVKY

Lukáš Tábořík, Jakub Mužík

Abstract

Currently one of the major thing of these days is global problems on the Earth. This fact is caused, among other things, by excessive urbanization, which brings an increase in the development of the open landscape. This effect in unstoppable but we can mitigate the impact by planting suitable vegetation which is physiological and physical properties is able to cool the surrounding environment, enrich the components of the atmosphere with oxygen and retain water in the landscape which is otherwise quickly drained due to unfit management. This effect is affecting local and global circulation of water, the hydrosphere.

Topic of plants in the cities is actual and it is important to pay sufficient attention of it. Plants have a major impact on the sustainability of water in the landscape, air quality and reducing temperatures. This effect is not realizing for many people. The meaning of this Inquiry based education is apprise students with this problems. Emphasis is situated on understanding the seriousness and importance of this topic, Students will get knew with the factors that affect these processes and they will be convinced by research on how important and essential vegetation in cities is.

This theses follows the publication of the author team of Vácha et al., which is entitled – The effect of inquiry based education on understanding of environmental importance of evapotranspiration. Our these besides evapotranspiration is situated on global impact of plants in city – especially temperature, oxygen production. This factors the students in based education will be able to prove with special tools on themselves. The overall benefit should be the creation of contexts and opinions regarding the planting of plants in the city and their overall contribution to the formation of living conditions on Earth, as well as the deepening of based education skills.

Key words: vegetation, evapotranspiration, global problems

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HOW DO STUDENTS FORMULATE A RESEARCH QUESTION AND CONCLUSIONS IN SCIENCE RESEARCH?

JAK ŽÁCI FORMULUJÍ VÝZKUMNOU OTÁZKU A ZÁVĚRY V PŘÍRODOVĚDNÉM BÁDÁNÍ?

Adam Nejedlý, Karel Vojíř

Abstract

Scientific thinking is an essential skill for full application in society associated with responsible human decision-making. The development of inquiry skills also contributes to its complexity. Inquiry skills are an essential part of science literacy. For the possibility of their systematic development, it is necessary to understand the current situation of students in primary schools. The aim of the research was to find out what are the skills of students in the field to correctly formulate a research question based on the characterized problem and ability to formulate an answer to a given research question. For this purpose, two experimental and two observationally oriented inquiry tasks were used. The tasks were solved by 58 Czech students from the seventh grade of primary school. It was found that more than half of the students were not able to formulate the research question correctly. More than one third of the students could not even formulate an answer to the given research question based on the performed research. In formulating the answer to the research question, a difference was found depending on the nature of the exploration phase. More students were able to formulate an answer to inquiry tasks using an experiment than to observational tasks. The results provide a pilot insight into the difficulties in inquiry skills. The causes of failure and the possibility of effective intervention require further research attention.

Key words: inquiry-based science education, scientific thinking, lower-secondary education

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HOW DO TEACHERS USE CHEMISTRY TEXTBOOKS COMPONENTS?

JAK UČITELÉ VYUŽÍVAJÍ KOMPONENTY V UČEBNICÍCH CHEMIE?

Karel Vojíř, Martin Rusek

Abstract

Textbooks represent the most specific form of curriculum used by both teachers and students. In view of this central role, textbooks are created to fulfil a wide range of functions. In the field of chemistry textbooks for lower-secondary schools, this corresponds to their high didactic equipment. However, the possible impact of individual components on education depends on their use. It reflects teachers' conception of textbook use in the context of their approach to teaching. The aim of this study was therefore to find out how important lower-secondary chemistry teachers consider individual textbook component, for what purposes and with what frequency they use them. To this end, a questionnaire survey was carried out on a random sample of chemistry teachers allowing statistical generalization (N = 387). The data was evaluated using the CRISP-DM data mining methodology. The results showed a high consistency in chemistry teachers' perception of textbooks as well as their rather conservative conception of teaching. Only eight components are considered by teachers to be relevant to the quality of teaching and are used rather frequently. Significant relations were identified in the use of individual components. This is especially valid for textual and graphical components. The research identified the components with the greatest potential influence on chemistry teaching. The high consistency in the teachers' perception of textbooks also points to the need for further teacher training in the possibilities of using other components.

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Key words: textbook, chemistry education, lower-secondary education, curriculum

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INTEGRATED SCIENCE: TEACHER'S AND STUDENTS' VIEW

INTEGROVANÁ VÝUKA PŘÍRODOVĚDNÝCH PŘEDMĚTŮ Z POHLEDU UČITELE A STUDENTŮ

Markéta Bartoňová, Dana Kričfaluši

Abstract

Integrated teaching can be defined as teaching that connects contents and aims of subjects created from individual sciences into a new whole. The introduction of integrated teaching into schools is possible by step-by-step method, that enables adaptation to a new approach to teaching for teachers as well as to a new approach to learning for students. The first possible step is to implement integrated teaching as a school club, the second step is to implement integrated teaching as an optional subject, the third step is to implement integrated subject (related for example to science subjects) to the offer of compulsory elective subjects and the fourth step is to implement integrated subjects in compulsory subjects. The contribution's aim, among other things, is to share author's experience with the Integrated Science club, that enables integration of contents and aims from chemistry, biology, physics, geography, geology, from the perspective of a teacher who has studied 2 of 5 named subject areas, but also students' view of the Integrated Science club. What motivates students for entering the club that connects multiple subjects? Is this style of teaching manageable even though the teacher has studied only 2 from the 5 subject areas? How to prepare for this style of teaching? The contribution reacts not only to these questions.

Key words: Integrated teaching, integrated science, teacher's view, students' view

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IS THE LEARNER'S COGNITIVE LEVEL A REFLECTION OF THE LEARNING ENVIRONMENT? PILOT RESEARCH

JE DOSIAHNUTÁ KOGNITÍVNA ÚROVEŇ ŽIAKA ODRAZOM VZDELÁVACIEHO PROSTREDIA? VÝSKUMNÁ SONDA

Dominika Koperová, Ľubomír Held, Andrej Kolarovič

Abstract

Many chemistry concepts are abstract. One of them is the concept of "atom", which represents a sub-micro level. Its understanding requires abstract thinking. According to Piaget's stages of cognitive development, a 11–12-year-old pupil achieves (or should achieve) the level of formal operations, which entails the ability of abstract thinking, and thus the ability to grasp even abstract scientific concepts adequately. The aim of the paper is to present a picture of learning environment based on relation between identified valuables – the stages of cognitive development of pupils, the misconception about atom and the summative assessment of chemistry as a school subject. Pupils' cognitive level was measured through the formal operation test designed by Patterson and Milakofsky. Misconceptions were identified by the bipolar statement scale. The results show differences between the groups of 14-15 year old pupils of lower secondary schools – one group learns in a traditional, predominantly deductive way (12 schools, 14 classes, 287 pupils) and the second group implements inductive approach (2 schools, 4 classes, 83 pupils).

Key words: science education, misconceptions, cognitive development, learning environment

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LAPBOOK AS AN EFFECTIVE EDUCATIONAL TOOL

LAPBOOK JAKO ÚČINNÝ VZDĚLÁVACÍ NÁSTROJ

Małgorzata Nodzyńska-Moroń, Danuta Jyż-Kuroś

Abstract

Constructivist learning theory assumes the student's activity and independence in acquiring knowledge. In this case, gaining knowledge is a process that takes place in constant interaction with the environment and confrontation with oneself, in order to ultimately lead to the reconstruction of the image of one's own world.

One of the tools for organizing self-acquired knowledge is the lapbook. It is something like a thematic folder in which the student collects information on a selected topic. There is room for information, drawings, stories, charts, words, deadlines or photos. All this is placed in pockets, books of various shapes and on sticky notes. Lapbook is therefore something like an interactive briefcase resembling a paper theater that fits on our lap, hence its name.

The article describes the research of high school students who made their own lapbooks. The influence of creating lapbooks on students' school achievements was described and the quality of the created lapbooks was compared.

Key words: lapbook, science education, constructivism

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OPEN-ENDED PROJECT ON SUSTAINABILITY: FROM STUDENTS' QUESTIONS TO PEDAGOGICAL MODELS

Justyna Mikolajczyk, Merve Karasari, Darpin Mihcioglu, Jan Lundell

Abstract

In spring 2021, a teacher education course for exchange students was held at the University of Jyväskylä. Due to the covid-19 pandemic and the restrictions it imposed on contact teaching, the course had to be delivered in virtual mode. Therefore, the course was run in an open-ended mode, i.e. without a well-defined learning target nor learning outcome. The whole virtual course was built on project-based education and focused on sustainability. As a teacher training course, the hidden agenda was to use a pedagogical model where the students are active participants in building up the course and its content, but also act as researchers collecting data and analysing it. This was done to engage the students in the course and to demonstrate the possibilities of collaborative and co-creative learning. The whole course and research set-up was relying on the input from the students, and the content depended on the questions and comments the students delivered regarding sustainability. Altogether 30 questions were used as preliminary input that guided the course and research activities. This led eventually to a pedagogical model to be used to gain insight on the role and employment of aspects of sustainability (socio-cultural, economical, environmental) in educational contexts like curricula, lesson plans, teaching materials and laboratory exercises. These aspects of sustainability were further analysed according to the content of the preliminary questions used with relations to knowledge or fact, perception or awareness, and decision making or taking actions. This categorization can also be related to the fields of engagement according to Fredericks et al. (2004) as cognitive, emotional and/or affective, and behavioral engagement, respectively. All in all, the course was found to be multifaceted learning and teacher training course giving students insights on how project-based approach can be realised in virtual world, how to engage students and to promote their ownership in the course development "on-the-fly" and how to assess the progress and the outcomes of the project from the point of an active participant and as a researcher. Moreover, the tool to map sustainability in educational contexts developed as a product of the project has already been applied to analyse biology teacher curricula (Mikolajczyk, 2021), as well as adopted as a working tool for FORTHEM EU-level University network to assess sustainability in their actions.

Key words: project-based education, sustainability, co-creation, collaborative learning, virtual learning

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PRE-SERVICE TEACHERS' AND EXPERTS' PROBLEM SOLVING SKILLS: A COMPARISON ON A CHEMISTRY AND SCIENCE PROBLEM TASKS

Martina Tóthová, Martin Rusek

Abstract

Problem solving as one of the 21st Century Skills belongs among areas Czech students' do not excel in, as shown in PISA. Students' ability to solve problem tasks should be implemented in curriculum and therefore be developed by teachers. However, in order to do so, they need to be successful problem solvers themselves. This contribution dealt with chemistry pre-service teachers' problem solving skills which were compared with experts'. The pre-service teachers (n = 3) of various success-rates were given one chemistry and one general science task. Their performance was compared with experts (PhD or PhD candidates) (n = 3). The results of eye-tracking, retrospective think-aloud and interviews proved students' relatively low ability to solve the tasks. Despite the differences in performance, differences in the attention paid to individual parts of the tasks between students and experts were insignificant. The think-aloud and interviews revealed that the pre-service teachers considered the chemistry task more difficult. They saw chemistry context as something they should remember. On the other hand, experts considered the scientific task more difficult because of the need to of an overview and knowledge from several disciplines combination. The students' results were also affected by reading. The results explain the reason behind the students' failure and will be focused on in the university courses.

Key words: eye-tracking, problem-solving, chemistry education

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PROJECT STEMKEY – THE IMPORTANCE OF PROMOTING CORE COMPETENCES IN FUTURE STEM TEACHING

PROJEKT STEMKEY - DŮLEŽITOST PODPORY KLÍČOVÝCH KOMPETENCÍ V BUDOUCÍ STEM VÝUCE

Katja Maass, Martin Bilek

Abstract

STEMkey as international Erasmus+ project stands for 'Teaching standard STEM topics with a key competence approach'. The project's objective is to transform future teachers' approach to teaching standard STEM topics. To achieve that, we want to rethink, reshape and redirect the delivery of fundamental STEM subjects knowledge in the direction of key competence development. We want to encourage future teachers to refrain from teaching with the sole purpose of knowledge-transfer of a single STEM subject, isolated from other STEM subjects. This simply does not measure up to todays and tomorrows challenges and requirements anymore.

Instead, through STEMkey we empower future teachers to nurture their students' key competences when delivering standard STEM content (Functions and Measurement from Mathematics, Electricity and Light from Physics, Periodical System and Chemical Reaction from Chemistry, Human Anatomy and Physiology and Material Cycles from Biology, Household Appliances from Engineering, Technical Materials from Technology and Algorithms and Data from ICT). To achieve this objective we develop teaching modules with above mentioned topics to be used in higher education programs for future STEM teachers, which will transform future STEM teachers' teaching abilities. More information about project: https://icse.eu/international-projects/stemkey/.

Key words: STEM education; project STEMkey; key competences; international cooperation

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PROJECT-BASE EDUCATION SUPPORTING VIRTUAL EXCHANGE STUDENTS' ENGAGEMENT TO STUDIES

Leena Mattila, Jan Lundell

Abstract

The academic year 2020-2021 was impacted heavily by Covid-19 pandemic, and it imposed new needs and solutions for studying and teaching. Accordingly, this made also normal on-site student exchange impossible since only a few students could travel to other country. As almost all teaching in higher education everywhere in the world was online, also virtual exchange possibilities became real and foremost way to study abroad. Going for exchange is still much more than just studies. It is experiencing the foreign country and student life. New "Covid normal" was something different. Students were looking for different kind of support to handle their loneliness and other real-life challenges besides study counselling. Planning studies and organizing teaching to support students' engagement and motivation was more important than ever before.

Project-base education (PBE) gives increased possibilities for students to work together and feel to be part of a community especially in the digital world. At the Department of Chemistry, Jyväskylä University, a group of virtual exchange students participated on a PBE-focused, chemistry teacher education course on sustainability in spring 2021. The course content was adjusted according to the beliefs, real-life experiences and insights by the students in order to enforce the connection between teaching science and acting sustainable in society. This poster presentation is focusing on the views and experiences of the students presented after taking the course. The study is based on online group interview of the students. The main focus of this poster presentation is on the feelings and experiences expressed by the students. Here, we try to understand how studies incorporating interaction and common target-oriented goals could help them not only to engage in meaningful learning experiences but also to handle the hard times imposed by the restrictive pandemic times and develop their agency.

Key words: virtual exchange, agency development, project-base education

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PROMOTING MODEL COMPETENCE IN 5TH GRADE BIOLOGY LESSON ABOUT THE HUMAN BACKBONE

Danila Tran Thuy Duong, Holger Rainer Neumer

Abstract

Models are omnipresent in lifeworld as well as school routine. But biology students shall learn to use them not only as a method for transmitting information but as an instrument for scientific inquiry. This is why this research project tried to implement learning about models in a setting of inquiry-based science education (IBSE). Therefore, biology students in 5th grade were asked to build a model of the human backbone (vertebral column) and next present and evaluate their models with their classmates. Afterwards they reworked their models.

Data were collected with a questionnaire one week before and immediate after the intervention. The questionnaire contained forced-choice-questions developed by Krell & Krüger (2010), based on the model of model competence by Upmeier zu Belzen & Krüger (2010) and measured the level of student´s model competence. Students with low level model competence (I) understand models as simple copies of reality, while those with medium level model competence (II) will describe them as idealised representations. On third level model competence (III) students understand, that models can be tested and thereby gain knowledge and are thus an important method for scientific research.

Key words: model competence, IBSE, teaching biology

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STUDENTS' MISINFORMATION HUNT: A CASE STUDY

ŽACI NA LOVU MISINFORMACI: PRIPADOVA STUDIE

David Fatka, Svatava Janoušková

Abstract

This is a case study of open assignment in secondary education, targeted at misinformation related to chemistry. In the assignment, the students were to find the misinformation by themselves using the web with little direction. Therefore, the case study had twofold research aims, targeting both the difficulty of the very open approach to assignments to deal with and the recognition and debunking of misinformation in the students.

The case study discovered that similar tasks are rather complex to understand and approach, but after the students stop struggling with the task description, the quality of their work tend to be remarkable and they get well accustomed with the source declaration. In addition, the case study also discovered the seasonality of misinformation with the fashionable ones in the current times being the easiest to both find out and debunk. Also, a common evergreen in chemistry-based misinformation are fad diets of many different kinds. In many of the misinformation, the motivation for their spread can be traced to health concerns.

Key words: misinformation, open assignment, case study, source declaration

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STUDENTS' CONCEPTIONS ABOUT THE SENSE OF SMELL

Julia Dreyer, Elisabeth Hofer

Abstract

From the viewpoint of constructivism, learning is always a process of relearning, which is based on the things we already know. Learners themselves have to construct their knowledge actively; teachers are only able to support the process of learning. Considering students' prior knowledge and experiences, teaching-learning processes can be arranged in such a way that students are able to link the new concepts to their existing knowledge. For this purpose, researchers have been studying students' conceptions regarding various scientific topics for several years. However, there has not been research about students' conceptions regarding the sense of smell so far. This research gap was addressed as part of a bachelor thesis. In the course of this thesis, six German secondary science students (grade 6) were asked about their beliefs regarding the sense of smell. Each of the students participated in a semi-structured interview that was audiotaped and transcribed subsequently. To grasp students' conceptions, the interviews were analyzed applying the method of qualitative content analysis. In our talk, we will give an insight into the process of data analysis as well as the results emerging from this. Beyond that, we will present the implications for lesson planning and implementation arising from this study.

Key words: students' conceptions, Sense of smell, model of educational reconstruction

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SWEET KILLER

SLADKÝ ZABIJÁK

Kateřina Trojáková, Zuzana Škodová, Andrea Řezníčková

Abstract

The project called "Sweet Killer" deals with calorie intake with a focus on the representation of macromolecular substances, specifically carbohydrates. We were led to choose this topic of the project by the current situation (coronavirus pandemic), during which students do not have the opportunity to perform sports activities and thus their activity is lost in their normal daily routine. We want to relate this fact to bad eating habits, which are well known in children. The project is intended for secondary school pupils, specifically 8/9. year of studies. We plan the implementation at the primary school when the conditions for implementation take place. Through this project, we would like to introduce students to how the body works with calories and what role carbohydrates play in their diet. An important part of the project will be a discussion with an expert, to which students should contribute with their own questions. As this is a project that falls under the teaching of chemistry, it must not lack a certain form of experiment - specifically research activities aimed at proving carbohydrates in food.

Key words: income, expenditure, carbohydrates, project, group work, energy value

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TEACH YOURSELF FIRST SO YOU CAN TEACH OTHERS. HOW DOES THE SKELETON BUILD?

UČTE NEJPRVE SEBE, ABYSTE MOHLI UČIT OSTATNÍ. JAK SE STAVÍ KOSTRA?

Wioleta Kopek-Putała, Małgorzata Nodzyńska

Abstract

Learning by learning LdL (German: Lernen durch Lehren) is a constructivist teaching method in which students learn from each other. However, the main representative of the concept of teaching by teaching is the German teacher of French Jean-Pol Martin.

Based on this idea, a task was set for 7th grade elementary school students. It was a two-step process. In step 1, they should independently obtain information about the skeleton structure and create a model based on it. This model was to be used in teaching primary school students 4 about the construction of the human skeleton. This article describes the first part of the research. The research question in this part of the research was whether the pupils of the 7th year of primary school are able to learn the structure of individual elements of the skeleton of the human body during the construction of their model.

First, the level of basic knowledge was diagnosed using a preliminary test. In the next step, examples of constructed models are shown. These examples served as inspiration for the activities of their students. After compiling the models, a posttest was performed to verify changes in students' level of knowledge about this subject. The results of the research show an increase in students' knowledge.

Key words: LdL, creating models, self-education of a primary school student

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TEACHERS AND FACTORS INFLUENCING THEIR IMPLEMENTATION OF INQUIRY IN SCIENCE EDUCATION: RESEARCH REVIEW 2011-2021

UČITEĽ A FAKTORY OVPLYVŇUJÚCE JEHO IMPLEMENTÁCIU BÁDATEĽSKÉHO PRÍSTUPU V PRÍRODOVEDNOM VZDELÁVANÍ: PREHĽADOVÁ ŠTÚDIA 2011-2021

Viktória Kohutiarová, Katarína , Katarína Kotuľáková

Abstract

Understanding the factors influencing teacher's use of IBSE have potential to help to catalyse its overall implementation, as despite heretofore reformative efforts a limited success has been observed. Until now, numerous research projects have been conducted in this area trying to contribute to problem solution. The present paper aims to review 70 publications mainly from databases WOS and ERIC published between 2011 and 2021 that met the inclusion criteria and identify their implications as well as open questions for the next research. The review identifies 2 main categories of factors: teacher-centred factors (beliefs, experiences, teacher professional development programmes, etc.) that are more often a subject of study in comparison with teacher-perceived factors (contextual factors of time, support, curriculum, etc. described by teachers). The data imply necessity of changes in teacher preparation as well as in professional development programmes and curriculum. Implications for next research suggest studying various factors in different teacher contexts but also to address the relationship of individual factors and the types or components of inquiry implemented by teachers. Especially, further research is necessary in case of factors that were only subjectively reported by teachers to improve the level of their IBSE implementation.

Key words: teachers, science education, inquiry, factors

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TEACHING BIOLOGY FROM THE PERSPECTIVE OF NINTH GRADE PUPILS IN PRIMARY SCHOOLS

VÝUKU BIOLOGIE POHLEDEM ŽÁKŮ DEVÁTÝCH TŘÍD ZÁKLADNÍCH ŠKOL

Ina Rajsiglová, Viktorie Poneszová

Abstract

To provide biology teachers with practical advice, the aim of this study was to find out which teaching activities contribute to more enjoyable biology lessons according to Czech and Finnish pupils. During school year 2018/2019, 195 Czech ninth-graders from Prague and 178 Finnish ninth-graders from Oulu completed the questionnaire. Pupils evaluated which teaching methods they encounter in biology lessons and how these methods influence their enjoyment of these lessons. The collected data were statistically evaluated on an ordinal scale, and a chi-square test of independence was therefore used to compare the impact of teaching activities on Czech and Finnish pupils. Results show that the enjoyment of Czech pupils would be enhanced by excursions, the teachers' personal storytelling and implementing activities according to the pupils' choice. The enjoyment of Finnish pupils in biology would be supported by implementing topics and activities according to the pupils' choice and also the teacher's personal storytelling. Therefore, the results show that it would contribute to pupils' enjoyment of biology lessons if pupils had a greater influence on the form of biology lessons and if the teacher told them personal experiences more frequently. Finding out the influence of specific teaching activities on the pupils' enjoyment in biology lessons is important to create attractive lessons which could theoretically increase also pupils' interest in biology.

Key words: biology, teaching and learning methods, interest in biology

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THE COMPOSITION OF SOFT DRINKS AS A TOPIC OF A TEACHING EXPERIMENT FOR HIGH SCHOOLS

SLOŽENÍ NEALKOHOLICKÝCH NÁPOJŮ JAKO NÁMĚT VÝUKOVÉHO EXPERIMENTU PRO SŠ

Petr Obořil, Karel Kolář

Abstract

At present, the market offers an almost inexhaustible amount of soft drinks of various kinds. Drinks differ in appearance and taste, they contain different types of so-called food additives (dyes, flavor additives, preservatives, etc.). Currently, a group of so-called energy drinks emerged as popular among youth. Although the composition of soft drinks is indicated on the packaging, immediate evidence of the presence of these additives in the drinks can also have a significant motivating effect on students. Therefore, teaching experiments focused on the analysis of soft drinks using thin layer chromatography were proposed. The experimental tasks were focused on the detection of ascorbic acid, caffeine, taurine and sorbic acid, which represent flavor additives, preservatives, but also components of energy drinks. The experiments are intended for interested upper-secondary school students, especially grammar schools, and can be carried out in the form of selected practical exercises, workshops, inquiry activities etc.

Key words: composition of soft drinks, thin layer chromatography, teaching experiments

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THE IDENTIFICATION OF GIRLS' ATTITUDES TO STEM VIA SCIENCE CAMP "LAB TECHNOLOGY AND EVERYDAY LIFE CONSUMPTION"

Kateřina Chroustová, Martin Bílek

Abstract

The "Lab Technology and Everyday Life Consumption" science camp is one of the national activities of the European project Empower Girls to Embrace their Digital and Entrepreneurial Potential (GEM), which aims to promote the interest of girls aged 12 to 16 in STEM and the related field of ICT in the Czech Republic. It also has ambitions to inspire girls to choose a profession and do business in those fields. The two-day science camp took place at the Department of Chemistry and Chemistry Education, Faculty of Education, Charles University in two runs at the end of August and October. It includes short lectures and discussions with scientists in chemistry and related fields, but the main emphasis is on practical activities. The girls work with various laboratory equipment, such as computer-assisted measurement sensors, learn to handle basic laboratory operations and perform simple experiments. Their relationship to STEM and its components and connections with everyday life is identified before and after the end of the camp by a questionnaire created within the project. In this paper, we focus on the description of preparation, implementation and evaluation of the science camp, as well as on the results of the evaluation of attitudes of girls identified in questionnaire surveys.

Acknowledgement: This work is supported by project Empower Girls to Embrace their Digital and Entrepreneurial Potential (GEM).

Key words: GEM project, STEM, girls' attitudes to STEM, science camp

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THE QUALITIES OF TASKS IN INORGANIC CHEMISTRY BASED ON THE ANALYSIS OF ENTRANCE PROCEDURE AT THE FACULTY OF SCIENCE, CHARLES UNIVERSITY

VLASTNOSTI ÚLOH Z ANORGANICKÉ CHEMIE VYPLÝVAJÍCÍ Z ANALÝZY PŘIJÍMACÍHO ŘÍZENÍ NA PŘÍRODOVĚDECKOU FAKULTU UNIVERZITY KARLOVY

Martin Šrámek, Milada Teplá, David Šarboch

Abstract

The main purpose of the admission procedure is selecting the most suitable candidates for given field of study. However, it can also be used for evaluation of students' obtained level of knowledge in the specific field - the first goal of this paper. Another goal of this paper is to determine whether each task belonging in Inorganic Chemistry sufficiently helps selecting suitable candidates. Therefore, we decided to analyse Chemistry tests used in the admission procedure at the Faculty of Science, Charles University, between 2016 and 2019.

At first, we performed an item analysis of each test. Secondly, all items belonging in Inorganic Chemistry were divided into topic groups based on the specific knowledge necessary for solving the tasks. Within these topic groups, the parameters of each item (success rate, ULI(1/2) coefficient, RIR coefficient, instruction analysis) were compared one to another leading to the conclusions below.

The only topic belonging in Inorganic Chemistry indicated as difficult for candidates was reactions of metals with acids. However, the analysis revealed four topics insufficiently selecting suitable candidates, but also five areas of Inorganic Chemistry suitable for the admission procedure based on the qualities of the tasks within each topic. Moreover, the article presents specifications and recommendations for each topic belonging in Inorganic Chemistry regarding the content of the task as well as its structure.

Key words: admission tests, inorganic chemistry, item analysis, item difficulty, item discrimination

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THE ROLE OF THE INTERDISCIPLINARY ANIMATIONS IN EDUCATIONAL PROCESS

MEZIPŘEDMĚTOVÉ ANIMACE A JEJICH ROLE V UČEBNÍM PROCESU

David Šarboch, Milada Teplá

Abstract

The article summarizes the results of research dealing with the influence of interdisciplinary interactive animations on the learning outcomes and motivation of students in the teaching of chemistry and biology. The survey was conducted at four Czech secondary schools between 2018-2020 and was attended by 149 respondents. Pupils were divided into a control group, being taught without the use of dynamic visualization tools, and an experimental group, where teaching was supported by the above-mentioned animations. The basis for the research was the following hypothesis: "Pupils who work with animations in the teaching process, achieve better learning outcomes and are more motivated than students who did not use dynamic visualization tools." Two types of questionnaires were used in the survey: MSLQ (Motivated Strategies for Learning Questionnaire) and IMI (Intrinsic Motivation Inventory). Furthermore, students completed a pre-test and a post-test based on the content of the curriculum. The aim of these tests was to determine the level of knowledge of pupils before and after the research.

The collected data were statistically processed in IBM SPSS Statistics 25 program and subsequently evaluated. The results showed that pupils working with animations showed significantly greater interest in the subject matter and at the same time achieved statistically better results than pupils from the control group.

Key words: interdisciplinarity, animations, student motivation, science teaching

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TO INTEGRATE OR NOT TO INTEGRATE, THAT IS THE QUESTION: A DELPHI STUDY ON TEACHERS' OPINIONS ABOUT INTEGRATED SCIENCE EDUCATION

Martin Rusek, Barbora Kolafová, Markéta Bartoňová

Abstract

School subjects in Czechia are mostly being taught separately. There are several schools which decided to integrate them as enabled by the national curricula. On the brink of basic school's curricular reform, the question of integrating these subjects arose again. The paper presents results of a Delphi study among 15 Czech science teachers selected based on their ideas on the topic expressed in an online discussion. The study focused on their opinions about integrated science education. In a form of a SWOT analysis, the teachers were asked to name strengths, weaknesses, opportunities and threats of scientific subjects' integration. In three rounds, the opinions were reformulated and ordered due to the participants' rating. From the teachers' point of view, integrating science subjects in school offers better connection of scientific topics, enables closer connection to practice or strengthens the possibility to realize inquiry-based education. On the other hand, it is seen as time-consuming with insufficient teacher preparation and low support from schools. Yet it offers opportunities such as: presentation of a more complex view of the world, supporting teaming among students and also teachers or offers more possibilities to develop competencies. The risks teachers saw were: teachers' unwillingness to integrate if this was a decision on a state level, rigidity of the school system and lack of parents' understanding.

Key words: integrated science education, delphi study, teachers' opinions

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