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PROJECT-BASED EDUCATION AND OTHER STUDENT-ACTIVATION STRATEGIES AND ISSUES IN STE(A)M EDUCATION

XXIII.

BOOK OF ABSTRACTS

Dominika Koperová & Martin Rusek (Eds.)

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EMPIRICAL EVIDENCE ON OPPORTUNITIES AND CHALLENGES OF GENERATIVE AI IN EDUCATION

Stefan Küchemann

Abstract

Since the development of ChatGPT, the opportunities of generative artificial intelligence (GAI) in STEM education have been massively increased. The opportunities range from the automatic generation of virtual experiments, a multistep data analysis of research data, over the code generation for programming tasks to the feedback of students during learning. Besides these substantial possibilities, there are several concerns and challenges that arise from data protection to incorrect output, misuse and users' cognitive decline. In this talk, we present an overview of empirical evidence on opportunities and challenges that arise from the integration of GAI into higher education in STEM. Specifically, we focus on how to effectively collaborate with the GAI during learning and teaching and highlight sensitive aspects that lead to more effective learning rather than a cognitive overload or decline during the use of GAI.

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OPEN INQUIRY-BASED LEARNING *IN* SCIENCE *EDUCATION* – *CHALLENGES* AND SUPPORTIVE MEASURES

Elisabeth Hofer

Abstract

Open inquiry-based learning (IBL) has gained increasing attention in science education as a means to actively engage students in authentic processes of inquiry. At its core, it invites learners to develop their own questions, design and conduct investigations, and use evidence to draw conclusions. Research highlights the potential of open IBL to foster motivation, creativity, problem-solving skills, and scientific literacy. At the same time, open IBL poses considerable challenges for both students and teachers. Learners often struggle with formulating researchable questions, planning appropriate investigations, or coping with uncertainty in the research process. Teachers face high demands regarding planning, flexibility, and the ability to provide adaptive instructional approaches and differentiated scaffolding. Moreover, implementing open IBL is complex in terms of classroom management, curricular constraints, and the professional expertise required. This talk will discuss major challenges in the practical realization of open IBL in science education, drawing on both empirical findings and insights from science education practice. In particular, the role of adaptive approaches and scaffolding will be examined with regard to learners' diverse needs. Finally, perspectives from ongoing research projects will be presented, illustrating how targeted support materials and inclusive approaches can help overcome barriers and enable students to successfully engage in open IBL.

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PRACTICAL IMPLEMENTATION OF INQUIRY-BASED SCIENCE EDUCATION IN PRIMARY AND SECONDARY SCHOOLS

BADATELSKY ORIENTOVANÁ VÝUKA V PŘÍRODNÍCH VĚDÁCH

Václav Fiala

Abstract

The workshop focuses on practical aspects of implementing inquiry-based science education (IBSE) in chemistry and other science subjects at primary and secondary schools. Participants will go through the entire process — from formulating research questions and structuring lessons to using simple tools for scaffolding and assessing students' inquiry work. The session will also include work with learning objectives, their implementation, and evaluation. Participants are encouraged to bring their own thematic plans or other documents containing the learning objectives of the subjects they teach. The workshop will provide space for sharing experiences and developing concrete ideas and activities for classroom practice.

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HOW DO PRE-SERVICE CHEMISTRY TEACHERS READ GRAPHS AND TABLES? EYE-TRACKING EVIDENCE ON PROCESSING OF SCIENTIFIC DATA

Lucie Hamerská, Tereza Tesárková, Dominika Koperová & Martin Rusek

Abstract

Interpreting scientific data presented in graphs and tables is an essential component of science competence, yet pre-service teachers often struggle beyond basic data reading. This contribution reports on an eye-tracking study with first-year pre-service chemistry teachers (N = 10), who solved chemistry-related interpretation tasks presented in textual, tabular and graphical formats. Their visual behaviour was recorded using eye-tracking method and complemented by retrospective think-aloud protocols to reconstruct underlying processing strategies. The analysis revealed distinct patterns between successful and unsuccessful solvers. High performers devoted more fixations to relevant data regions and engaged in direct comparison of trends across conditions. By contrast, low performers often revisited the task instructions, skipped critical labels or focused on isolated values rather than global patterns. Time spent on descriptive elements, such as axes or titles, did not predict success, whereas repeated rereading of key information negatively related to performance in trend-based items. The findings indicate that difficulties in data interpretation do not stem solely from visual unfamiliarity with graphs and tables, but rather from insufficient strategic processing.

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FUNCTION ART: A DESIGN-BASED EXPLORATION OF MATHEMATICAL CREATIVITY THROUGH GEOGEBRA

Guillermo Bautista, Abril Armenta Franco, Andri Setiyawan, Dana Arif Lukmana & Zsolt Lavicza

Abstract

This presentation introduces Function Art, an approach that integrates mathematical functions and artistic expression within the STEAM framework using GeoGebra. Function art engages students in creating digital artworks using functions, such as linear, quadratic, and trigonometric functions. Through this process, learners transform abstract symbols into visual forms that emphasize symmetry, pattern, and balance, highlighting the aesthetic dimension of mathematics. The study employed a design-based research (DBR) methodology involving iterative cycles of design, implementation, analysis, and refinement. Each phase included the development of instructional materials, classroom facilitation, and collection of student outputs and reflections. This cyclical process allowed continuous improvement of the learning design and support materials. Outputs include student-generated artworks, evaluation rubrics, and a framework for integrating function art into mathematics education. Overall, the project demonstrates that function art can serve as a bridge between mathematics and art, offering students opportunities to explore mathematics as both a scientific and creative endeavour.

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INSTRUCTORS VS. TABLETS: WHO REACHES TODAY'S STUDENTS BETTER?

Mária Babinčáková, Radana Koudelíková & Pawel Bernard

Abstract

Chemistry, like many science fields, faces a global decline in student interest. To address this trend, educators introduce laboratory experiences, such as university visits, which expose secondary school students to the practical reality of chemistry often missed in textbooks. However, capturing and holding students' attention is increasingly difficult. Modern technology and social media have shifted young people's expectations of the educational process, challenging traditional teaching methods. This raises a question for educators: How do we adapt our instruction to meet the engagement needs of today's students? We introduce a research project currently underway at the Jagiellonian University that directly addresses this challenge. Students participating in laboratory exercises are no longer instructed via live tutor demonstrations of pipetting and titration. Instead, they receive their technical guidance through short-form instructional videos in a "Shorts" format. We examine whether integrating this familiar media can improve the student experience and instructional outcomes. We will showcase examples of these instructional videos and preliminary results of our research. The project "Odkrywaj z nami chemię" received funding from the state budget under the program of the Ministry of Science and Higher Education called 'Science for Society II', project number NdS-II/SP/0079/2024/01. The funding amount of 999,900.00 PLN constitutes the total value of the project.

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AI MEETS GIFTED EDUCATION: WHAT A STUDENT SURVEY REVEALS

Rıdvan Elmas, Merve Adiguzel Ulutas, Fangfang Mo & Rumeysa Gorgulu

Abstract

Artificial intelligence (AI) is rapidly transforming education and reshaping global competitiveness, profoundly influencing how gifted learners—key drivers of a nation's future innovation—learn and develop. Understanding how gifted students perceive and use AI is therefore crucial. This study aims to examine gifted students' views on AI, focusing on their familiarity with AI, its relationship with cognitive skills, ethical concerns, perceived risks, and future expectations. A survey design was employed, and the data were analysed using descriptive statistics. The instrument comprised five sections: demographics (4), familiarity with AI (6), AI's role in giftedness (15), ethical concerns and risks (7), and future expectations and aspirations (5), totalling 37 questions. Findings reveal that more than half of the students are familiar with AI technologies, indicating widespread basic awareness. Most participants believe AI supports talent development by enhancing learning processes and offering new opportunities for gifted learners. However, one-third expressed concerns about misinformation and job displacement. A large majority anticipate AI's major role in shaping social change, information exchange, and career pathways. Overall, gifted students perceive AI as a positive, innovative, and future-shaping force, while maintaining a mindful awareness of its ethical boundaries and potential societal implications.

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THE SILENT METAL EATER: WHEN FOOD ATTACKS

TICHÝ ŽROUT KOVŮ: KDYŽ POTRAVINA ÚTOČÍ

Kristýna Boušková, Lucie Lichtenbergová, Adam Kopecký & Lucie Morávková

Abstract

Understanding how different metals respond to food and beverage ingredients is useful not only in chemistry instruction but also in environmental awareness. This activity represents an inquiry-based teaching unit derived from a real scenario: a shipment of energy drink cans held by customs officials were warped and empty, with traces of intoxicated rats present beside them. As packaging designers, students are tasked to find the chemical cause of this failure and to provide practical alternatives. During the activity, students experiment with selected metals against model ingredients that mimic the composition of an energy drink. They formulate hypotheses, conduct and record experiments, observe and analyse various physical and chemical changes, and test the suitability of selected materials for packaging a drink, and apply results to real cases of sustainability and consumer protection. This activity combines chemical experimentation with authentic industry-benchmark challenges. The activity was piloted with 60 high school students over a total of 12 lessons in October 2025. Data is being collected and analysed using concept mapping to show isolated concepts, students' initial preconceptions, and the conceptual connection they developed during the learning process. Results, including students' experimental outcomes and proposed methodological improvements, will be presented at the conference.

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THE IMPORTANCE OF DATA SIMULATIONS FOR UNDERSTANDING SELECTED EXPERIMENTAL MEASUREMENTS IN PHYSICAL CHEMISTRY

VÝZNAM DATOVÝCH SIMULACÍ NA POROZUMĚNÍ VYBRANÝM EXPERIMENTÁLNÍM MĚŘENÍM VE FYZIKÁLNÍ CHEMII

Jan Břížďala & Erik Kalla

Abstract

Physical chemistry is an interdisciplinary field that requires knowledge of physics, chemistry, and the ability to apply mathematical concepts. For many students, a lack of understanding of physical chemistry may be due to either a misunderstanding of the chemical nature of specific problems or an inability to apply mathematics. The causes of these problems can be investigated in students, but for a comprehensive understanding, students need to be confident in both mathematical operations and the chemical nature of the problems. Laboratory measurements and their evaluation are a tool for demonstrating selected physical quantities. Examples include quantities such as the dissociation constant or buffering capacity, which can be determined by measuring changes in pH values during the titration of a weak acid solution (acetic acid) with a strong base (sodium hydroxide). This reaction produces an acetate buffer. The experiment allows the dissociation constant of acetic acid and the buffering capacity of the acetate buffer to be calculated. To assess the students' understanding of this issue, the results of three groups of students are evaluated. The first group is introduced to the problem only theoretically and formulates conclusions. The second group has data simulations at its disposal, and the third group performs its own laboratory measurements.

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COMPARISON OF THE EFFECTIVENESS OF LIVE AND VIDEO DEMONSTRATIONS IN CHEMISTRY EDUCATION

SROVNÁNÍ EFEKTIVITY REÁLNÝCH DEMONSTRACÍ A VIDEODEMONSTRACÍ VE VÝUCE CHEMIE

Kateřina Matějů & Eva Štanhanzlová

Abstract

The aim of this paper is to compare video demonstrations and live demonstrations performed by a teacher during chemistry lessons at a lower secondary school, focusing on their effectiveness and students´ engagement. The first aim of the research was to compare the effect of the selected methods of chemistry reactions´ presentation. The second aim was to compare their impact on students´ knowledge retention and understanding of the subject matter. Demonstrations that are simple, safe and easily feasible in a classroom environment were used for the research. In connection to an ongoing research, the same video demonstrations were used, while the live demonstrations were performed by a member of the student research team. The research sample consisted of two classes of ninth-grade students, with a different video and live demonstration being performed in each class. Students first completed a questionnaire concerning their attitudes toward chemistry, chemistry demonstrations, and their frequency in lessons. Later, they watched one live and one video demonstration. After each demonstration, students filled in a follow-up worksheet focused both on knowledge retention and attitudes. Based on the results, conclusions will be drawn and presented at the conference. The purpose of this research is to highlight the importance of effectively presented demonstrations in chemistry education and to serve as an argument for their inclusion in teaching, whether in live or video form.

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FROM DATA TO CONCLUSION: STUDENTS' SKILLS IN INQUIRY-BASED LEARNING

OD DAT K ZÁVĚRU: DOVEDNOSTI ŽÁKŮ V BADATELSKY ORIENTOVANÉ VÝUCE

Tereza Dvořáková, Adam Nejedlý & Karel Vojíř

Abstract

The development of scientific skills is a key prerequisite for shaping students' scientific literacy and their ability to understand the world through evidence. The ability to work with data, draw conclusions, and reflect on one's own findings is essential for fostering students' critical and analytical thinking. This paper focuses on students' success in recording data and formulating conclusions when solving observational and experimental inquiry-based tasks. An analysis of students' responses showed that most of them were successful in recording data in both types of tasks and were able to accurately capture relevant information, with over 90% using appropriate technical terminology. On the other hand, students achieved lower success rates in formulating conclusions. Most did not support their conclusions with the data obtained and failed to consider the limitations of the observation or experiment. The results highlight the key role of supporting students in developing data analysis skills, in interpreting results, and in formulating evidence-based conclusions, emphasizing the need for targeted interventions in inquiry-based learning.

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ACTIVE LEARNING METHODS IN BIOLOGY AND CHEMISTRY LESSONS

AKTIVIZAČNÍ METODY V HODINÁCH PŘÍRODOPISU A CHEMIE

Kateřina Čiháková

Abstract

As teachers, we face the challenge of meaningfully educating Generations Z and Alpha — students growing up in a digital world who seek purpose, connection, and the development of critical and creative thinking. The workshop offers insight into who today's learners are and how the teacher's role is changing: from being the sole source of knowledge to becoming a guide and facilitator. Together, we will explore key questions such as: *What defines active learning methods? What makes a modern teacher, and why do they teach the way they do? How can we connect content, skills, and competencies so that learning becomes engaging for both students and teachers?* The workshop includes practical examples of lesson units in biology and chemistry that apply inquiry-based learning, creative and critical thinking, and student collaboration. Its goal is to inspire modern teaching practices that embody the principles of learning through play and responsive education.

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THE SUBJECT "SCIENCE" AS THE FUTURE OF SCIENCE EDUCATION

PŘEDMĚT SCIENCE JAKO BUDOUCNOST

Tomáš Jedlička

Abstract

The lecture is intended for students of the Faculty of Education who are interested in teaching science subjects in a broader interdisciplinary context. It offers a reflection on four years of experience with teaching the subject Science at a lower secondary grammar school, where different areas of natural sciences are integrated into one cohesive whole. The lecture will focus primarily on the purpose and benefits of such an approach — how Science helps students develop an understanding of the world around them, supports critical thinking, and encourages them to connect scientific concepts across disciplines. It will also include reflections on experiences with team teaching — cooperation between two teachers — and how this form of instruction influences classroom dynamics, relationships with students, and teachers' professional growth. The aim of the lecture is to inspire participants to think about what it truly means to teach science meaningfully — not only to transmit knowledge, but to guide students in discovering relationships and understanding the world in its complexity

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NEW POLISH CHEMISTRY CURRICULUM FOR PRIMARY SCHOOLS: CONTENT ARRANGEMENT AND ROLE OF EXPERIMENTS

Paweł Bernard & Mária Babinčáková

Abstract

In recent years, a decline in students' interest in natural and exact sciences has been observed across all stages of education. The number of students taking the chemistry matriculation (matura) examination in the past ten years has decreased by one-third, and this effect cannot be attributed to demographic factors. Furthermore, the average score on the 2024 chemistry examination—38% (with a median of 33%)—contributes to the perception of chemistry as a difficult school subject. Therefore, it is not surprising that one of the objectives of the ongoing educational reform is to change the image of chemistry and the natural sciences and to increase the participation of students in these subjects. This is to be achieved, i.a., through the introduction of new curriculum based on active methods including students' independent inquiry. During the presentation, the main ideas of the new core curriculum together with the conclusions from the current projects for primary schools will be discussed.

The project Odkrywaj z nami chemię received funding from the state budget under the program of the Ministry of Science and Higher Education called 'Science for Society II', project number NdS-II/SP/0079/2024/01. The funding amount of 999,900.00 PLN constitutes the total value of the project.

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WHY INCLUDE BOTANICALLY ORIENTED STEM LEARNING ACTIVITIES IN CLIMATE EDUCATION?

Renata Ryplová, Zbyněk Vácha, Tomáš Mrhálek & Tereza Brčáková

Abstract

The contribution examines the current structure and focuses of climate education in the international context, drawing on the authors' empirical research and recent bibliometric studies. It argues that the integration of botanically oriented STEM learning activities is essential for a more comprehensive understanding of climate change processes and mitigation strategies. Despite the crucial role of vegetation in carbon sequestration, evapotranspiration, water retention, and local climate regulation, plants remain underrepresented in formal climate education and are often perceived by students as uninteresting or irrelevant. The paper discusses the educational potential of plant-centred STEM approaches to enhance students' awareness of ecosystem services, their understanding of the functional importance of plants, and their capacity for systems thinking. Based on recent findings on environmental locus of control and eco-anxiety among Czech students, it is proposed that such learning activities can reduce climate-related distress and foster a stronger sense of personal agency and responsibility in the context of global environmental change. Integrating botanical content into STEM-oriented climate education may thus contribute not only to cognitive development but also to the cultivation of emotional resilience and pro-environmental behaviour.

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PROJECT-BASED EDUCATION IN SCIENCE CLASSROOM: PROMOTING STUDENTS' CURIOSITY AND CONCEPTUAL UNDERSTANDING OF ENVIRONMENTAL TOPICS

Martin Jáč

Abstract

Project-based education is a constructivist, student-centred form of teaching and learning that enables active engagement of students in learning tasks across different school subjects, including science and environmental education. Environmental education was introduced into the Czech curriculum at the national level approximately two decades ago as a cross-curricular topic at both primary and secondary education levels, covering a wide range of environmental topics, including human impact on the environment and the basic principles of nature conservation. In this respect, environmental education is a particularly relevant area for project-based education. The paper will provide examples of the implementation of project-based education in science instruction, with an emphasis on environmental topics, from the author's perspective as an in-service biology and geography teacher in a grammar school. Specifically, the paper will present the implementation of the national project Acid Rain and the international project GLOBE (both projects were coordinated in the Czech Republic by the non-governmental non-profit organisation Tereza) into science lessons, including selected student outputs that illustrate the impact of project-based education on promoting students' curiosity and their conceptual understanding of selected environmental topics.

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INQUIRY-BASED SCIENCE EDUCATION – TOXIC EFFECTS OF HEAVY METAL COMPOUNDS

BADATELSKY ORIENTOVANÁ VÝUKA – TOXICKÉ PŮSOBENÍ SLOUČENIN TĚŽKÝCH KOVŮ

Tomáš Hrbáček, Karel Kolář, Rafael Doležal & Martin Bílek

Abstract

The paper focuses on the creation of a specific example of IBSE based on a chemical experiment with a view to its application in chemistry teaching at secondary schools. The object of the experiment is the reaction of the substance under investigation with a reactant to form the corresponding product. The task is to explain the nature of the formation of the product of this reaction using simple laboratory techniques. The conceptual design of the experiment is based on the fragmentation of the reactant molecule, the assignment of specific compounds to individual fragments, and the subsequent reaction with these compounds. In our case, this involves investigating the reaction of heavy metal compounds, specifically lead salts, with proteins and peptides. The project is designed so that students gain a deeper insight into the nature of the reaction, the nature of the toxic effects of heavy metal compounds, their impact on the environment, etc., through simple experiments and their own research. The practical part of the work includes the following experiments: the reaction of lead acetate with albumin, glutathione, individual amino acids, and compounds derived from amino acid fragments. We are investigating which reactions produce insoluble products and what the nature of their formation may be. Based on these analyses, it is possible to reveal the principles of the formation of insoluble products and the related nature of the toxic effects of lead compounds.

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E-NUMBER HUNTERS

LOVCI ÉČEK

Jessica Kailová, Sára Holubová, Karolína Nováková & Kateřina Lišková

Abstract

The educational activity E-Number Hunters was developed as an inquiry-based learning unit for lower-secondary students (Grade 9) in chemistry and health education. Its aim is to help students recognize and evaluate food additives (E-numbers), understand their chemical properties and functions, and reflect on their impact on food quality and human health. The activity fosters scientific literacy, critical thinking, and informed consumer decision-making. Students work collaboratively at four experimental stations focused on preservatives, emulsifiers, stabilizers, and colorants. Each station includes simple hands-on experiments, guided observation, and reflection tasks recorded on individual "researcher cards." The lesson begins with a pre-test assessing students' initial awareness and misconceptions about food additives and concludes with a post-test evaluating changes in knowledge and reasoning. The activity connects chemistry with everyday life, highlighting the relevance of scientific understanding to responsible consumer behaviour. It also supports communication, collaboration, and argumentation skills through group discussion and analysis of real food products. The pilot implementation with Grade 9 students in October 2025 provided feedback that led to improvements in structure, clarity, and learning outcomes. Results indicate the activity is feasible and effective for lower-secondary education.

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FUTURE TEACHERS' READINESS AND ATTITUDES TOWARDS STEM/STEAM APPROACH IN THE CZECH REPUBLIC

PŘIPRAVENOST A POSTOJE BUDOUCÍCH UČITELŮ KE KONCEPTU STEM/STEAM V ČESKÉ REPUBLICE

Daniela Šupíková

Abstract

In the light of the recent reform of the educational system in the Czech Republic, which includes model school curricula emphasizing the integration of science subjects (chemistry, biology, physics), the broader implementation of STEM/STEAM education is inevitable. The STEM/STEAM approach not only fosters interdisciplinary connections but also plays a crucial role in developing students' digital competencies and critical thinking. For the broader implementation of STEM/STEAM principles in teachers' everyday practice, it is essential to have educators who are familiar with this concept and capable of designing lessons accordingly. How prepared are current students in STEM/STEAM disciplines for such approach? How is the STEM/STEAM concept perceived by students who will participate in the education of future generations? What challenges have they encountered when implementing STEM/STEAM activities in their teaching practice, and what do they consider to be motivating factors for its implementation? This paper presents findings that address these questions, based on research conducted among university students in the Czech Republic enrolled in fields falling into STEM/STEAM concept. The data were collected through an online questionnaire via Google Forms. The obtained results offer a foundation for discussing potential changes in the education of students enrolled in STEM/STEAM disciplines.

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BLOCK TEACHING IN PRACTICE: WATER ACROSS SCIENCE SUBJECTS

BLOKOVÁ VÝUKA V PRAXI: VODA NAPŘÍČ PŘÍRODOVĚDNÝMI OBORY

Edita Machová

Abstract

This demonstration lesson presents a model of block (interdisciplinary) teaching for 9th-grade students, applying the principles of project-based learning and active learning strategies within STE(A)M education. In the thematic block WATER, participants will practically experience selected stations in the same way as students rotate through them, while also being introduced to additional activities at the theoretical level. The demonstration shows how chemistry, physics, biology, geography, and environmental education can be interconnected into one coherent whole. The lesson includes experimental, exploratory, and inquiry-based activities, work with real materials, sensory exploration, construction tasks, observation, and deduction. It links scientific reasoning with ecology, geographical context, and students' everyday experiences. This form of block teaching develops inquiry skills and independence, naturally integrates content across disciplines, supports collaboration, rotation of roles, and group work. It uses authentic situations and experiments without the need for expensive equipment and allows for differentiated engagement of all students. Participants will gain concrete inspiration on how to structure block project-based teaching, organize learning stations, and effectively integrate active learning strategies into practical STE(A)M education.

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QUAIL INCUBATOR AND EGG DISPENSER AS INTERDISCIPLINARY STEM PROJECTS CONTROLLED BY BBC MICRO:BIT MICROCONTROLLER

Benjamín Kovács, Miroslav Šebo & Erik Krajinčák

Abstract

The paper focuses on two interdisciplinary STEM projects: a quail incubator and an egg dispenser, both controlled by the BBC micro:bit microcontroller. The aim was to connect biological processes with technology, programming, and sensor applications so that primary school students could practically explore the links between natural sciences and technical disciplines. In the incubator, students worked on temperature regulation using a sensor and a heating element, thereby gaining experience with the principles of environmental control for organism development. In the egg dispenser, they became familiar with timers, sensors, and the planning of automated processes, which are directly related to real agricultural applications. Questionnaire analysis showed that most students (more than two-thirds) strongly agreed that the tasks were instructive and understandable. Respondents reported that through these activities they better understood temperature regulation, the connection between biology and technology, and the importance of responsible animal care. Most students appreciated the practicality of the projects and recognized their relevance to real-life contexts. The results confirm that both projects represent an effective form of innovative teaching, which develops digital competences, fosters teamwork, and motivates students to engage with STEM fields.

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TEACHERS' PERCEPTIONS OF 3D PRINTING AND ITS APPLICATION IN EDUCATION

Zuzana Nedvědová & Lukáš Rokos

Abstract

3D printing represents a technology with high potential for project-based and active learning methods as well as for integrative approaches such as STEM education. However, its practical use in schools remains limited. This study focuses on lower secondary school teachers' attitudes towards the use of 3D printing in teaching, their perceived self-efficacy in working with the technology, and the factors they consider essential for its effective classroom integration. Based on the analysis of responses from over two hundred teachers, 3D printers are already available in many schools, yet their use is still sporadic and depends mainly on individual, highly motivated teachers. The main barriers identified include teachers' uncertainty and lack of practical skills, as well as limited technical or organisational conditions within schools. Although most respondents perceive 3D printing as a promising tool for educational innovation, only a minority of teachers feel fully confident to integrate it into teaching. Teachers particularly value its potential for individualisation, student engagement and motivation. The study contributes to understanding how teachers perceive the opportunities and limits of 3D printing in education and offers suggestions for more effective implementation of this technology.

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AUTOMATED AQUARIUM AS AN INTERDISCIPLINARY STEM PROJECT IN EDUCATION

Miroslav Šebo, Erik Krajinčák & Benjamín Kovács

Abstract

The paper presents an interdisciplinary STEM project focused on the design and implementation of an automated aquarium using the BBC micro:bit microcontroller. The project allows for the interconnection of natural science topics, such as ecosystems and the regulation of living conditions, with technical and digital skills – programming, electronics, and working with sensors. The automated aquarium was experimentally tested in an elementary school, where students performed tasks focused on lighting control, water temperature regulation, filter control, and working with sensors. Analysis of the questionnaires showed that most pupils found lighting programming and temperature regulation instructive and understandable, with up to two-thirds of pupils stating that the tasks helped them to better understand the principles of sensor technology and regulation. Working in teams promoted cooperation and problem solving, with most respondents reporting no significant technical difficulties. The project thus demonstrated high educational potential—students were actively involved, developed digital skills, and gained practical experience in applying STEM knowledge to a real-world problem. The automated aquarium proved to be an effective teaching aid that promotes motivation, creativity, and interdisciplinary connections.

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STUDENTS' LEARNING IN UNDERGRADUATE PROJECT-BASED MATHEMATICS COURSES

Chantal Buteau & Eric Muller

Abstract

In this presentation, I will discuss results from a 6-year-long naturalistic study about students' learning in a sequence of three project-based undergraduate mathematics courses, offered at our institution since 2001. In these courses, mathematics majors and future mathematics teachers learn to design and program interactive environments to investigate mathematical concepts, conjectures, theorems and real-world situations. Using data primarily collected through post-course voluntary anonymous online questionnaires, the focus will be two-fold: (a) what students perceived to be their most memorable learning experience and (b) what they perceived to be greatest learning outcomes from the three project-based courses. Results from this empirical research suggest that students learn the most when they choose their own topic of investigation, and from which they learn both operational and predicative kinds of knowledge, and that overall, they gain cognitive and non-cognitive skills.

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ESCAPE FROM LABORATORY – EDUCATIONAL BOARD GAME

ÚNIK Z LABORATOŘE – EDUKAČNÍ ÚNIKOVÁ HRA

Anna Kandybová

Abstract

This work focuses on design, implementation and evaluation of an educational escape board game aimed at teaching biochemistry, specifically the topic of proteins to upper secondary school students. The game is conceived as an active learning method with the objective of examining whether it can serve as an alternative to traditional teaching and support effective knowledge acquisition. The findings may contribute to the discussion on integrating game based and active learning methods into chemistry education and to the development of modern didactic approaches at the secondary school level.

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AN INQUIRY-ORIENTED DESIGN OF THE FIRST CHEMISTRY LABORATORY EXERCISE

BADATELSKY ORIENTOVANÉ POJETÍ ÚVODNÍHO LABORATORNÍHO CVIČENÍ VE VÝUCE CHEMIE

Filip Lambert, Jiří Pavlečka, Veronika Hahnerová & Jan Čermák

Abstract

This work presents an innovation of the introductory chemistry laboratory exercise at the lower secondary level. The aim was to foster students' interest in experimental work through an inquiry-based approach that encourages them to explore principles of separating components of mixtures. The activity was designed to guide students in formulating hypotheses, proposing procedures, conducting experiments, and interpreting results. Before the experiment, students are introduced to basic safety rules and proper laboratory conduct, forming the framework for independent work. The exercise serves as a foundation for later laboratory practice and develops reasoning and planning skills. The activity supports the development of practical skills, critical thinking, and the ability to apply theoretical knowledge in real-life contexts. Students learn to distinguish types of mixtures, select appropriate separation methods, and record their observations. It also promotes problem-solving, communication, and teamwork. The exercise was pilot tested in two lower secondary classes and analysed for its effectiveness, motivational potential, and didactic suitability. The results will guide further refinement and provide recommendations for chemistry teachers implementing inquiry-based learning in laboratory settings.

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FIELDWORK AS A FORM OF EXPERIENTIAL LEARNING: THE IMPACT ON PRE-SERVICE TEACHERS' ATTITUDES TOWARDS GEOLOGY

TERÉNNE CVIČENIE AKO FORMA ZÁŽITKOVÉHO UČENIA: VPLYV NA POSTOJE BUDÚCICH UČITEĽOV KU GEOLÓGII

Alexandra Maruniaková, Magdaléna Hadová, Katarína Imreová, Ivan Iľko & Viera Peterková

Abstract

Active learning strategies represent a set of pedagogical approaches that engage students in the learning process through discovery, experimentation, and reflection. In the context of geoscience education, these approaches are particularly valuable as they enable the connection between theoretical knowledge and real-world natural phenomena. This paper presents an example of applying active learning strategies through a fieldwork-based course designed to foster interest in geology and the abiotic components of nature among pre-service teachers. The course included activities such as observing geological phenomena in natural and mining environments, gold panning, pyrite extraction, and creating personal collections of rocks and minerals. These experiences support experiential learning, develop practical skills and critical thinking, and contribute to forming a constructive relationship with the subject matter. The research, conducted using a pretest–post-test questionnaire, examines changes in students' attitudes toward geology and its teaching across cognitive, affective, and behavioural dimensions. The findings highlight the strong potential of field-based activities as part of active learning strategies in teacher education and provide recommendations for more effective integration of geoscience topics into science education.

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THE ROLE OF PLANTS IN MITIGATING CLIMATE CHANGE AS A TOPIC FOR STEM EDUCATION IN SECONDARY SCHOOLS

ÚLOHA ROSTLIN PŘI ZMÍRŇOVÁNÍ KLIMATICKÝCH ZMĚN JAKO TÉMA VZDĚLÁVÁNÍ V OBLASTI STEM V PROSTŘEDÍ STŘEDNÍCH ŠKOL

Zbyněk Vácha, Renata Ryplová & Tomáš Mrhálek

Abstract

The primary objective of this paper is to assess secondary school students' understanding of the role of plants in mitigating climate change (one of the model topics of STEM education). Data were collected using a questionnaire. The results show that students are generally aware of the impact of plants on climate change, but struggle to put it into context and, in most cases, provide inadequate and unrealistic examples. They perceive the importance of plants for the climate primarily in terms of their role in oxygen production. At the same time, they have minimal awareness of carbon dioxide storage or the cooling function of plant cover.

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FORMATIVE ASSESSMENT AND WORKING WITH TEXTS IN SCIENCE EDUCATION

FORMATIVNÍ HODNOCENÍ A PRÁCE S TEXTEM V PŘÍRODOVĚDNÉM VZDĚLÁVÁNÍ

Veronika Laufková, Tadeáš Matěcha & Dominika Koperová

Abstract

The workshop connects science education with reading literacy and formative assessment. Participants will explore ways of working with literary and popular science texts. Through a specific example, they will try out how formative assessment strategies can be used to develop students' understanding of natural phenomena as well as their language expression. The workshop is designed for teachers of science subjects at primary and secondary schools who wish to discover approaches to teaching about nature with understanding, creativity, and joy of learning. The final part of the workshop will focus on reflection and on transferring the tested strategies into participants' own teaching practice.

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CONCEPT MAPS: INSIGHTS INTO STUDENTS' UNDERSTANDING OF PHOTOSYNTHESIS

Tereza Brčáková & Renata Ryplová

Abstract

Understanding photosynthesis represents one of the key challenges in biology education, as students often construct fragmented or mechanistic conceptions of this complex process. This study focuses on the use of concept maps as a tool for assessing students' conceptual understanding of photosynthesis and compares their outcomes with results from a traditional knowledge test. The research was conducted during biology lessons that implemented a digital textbook focused on photosynthesis and the role of plants in ecosystems. Data were collected through a knowledge test and concept map tasks administered before and after the instructional intervention. Concept maps were evaluated according to Novak and Gowin's (1984) criteria, considering the number of concepts, correct and incorrect links, hierarchical levels, and cross-links. The comparison of both approaches aims to provide a deeper understanding of students' conceptualization of photosynthesis and to describe how their knowledge is structured and interconnected.

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STUDENTS' PERCEPTIONS OF PROJECT-BASED LEARNING WITH MICROCONTROLLERS

Gabriel Bánesz, Miroslav Šebo & Hilda Hyneková

Abstract

Microcontrollers play a significant role in everyday life and can be found in a wide range of commonly used devices. Their integration into the educational process at primary schools was implemented as part of the KEGA project Microcontrollers in Interdisciplinary Education. One of the project outputs consisted of student learning materials designed to support the development of practical projects focused on water purification and the control of an automatic washing machine model using the BBC micro:bit microcontroller. These materials were structured to encourage students to explore, create, measure, and program. The paper presents student-created projects as well as their attitudes towards the provided information and tasks required for successful project completion. The results are summarized using descriptive statistics and student work evaluation, highlighting the benefits of integrating microcontrollers into education for the development of students' technical and environmental competencies.

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GAMIFIED KAHOOT FOR STUDENTS, OR PLAIN GOOGLE FORMS FOR CHEMISTRY TEACHERS? A FOCUS GROUP STUDY

Patrik Pospíšil, Veronika Švandová & Bohuslav Drahoš

Abstract

Digital assessment tools (DATs) have the potential to support the evaluation of teaching-learning outcomes and to enhance the effectiveness of this process. There are dozens of different DATs that teachers can use. The question is what criteria guide their choice. Another question is whether teachers' preferences coincide with the DATs that suit their students. Furthermore, is chemistry teaching somehow specific in the demands on DATs? The presented qualitative study should address these questions. A focus group study was chosen as the research method. Four different group discussions were conducted – with elementary school pupils, with high school students, with pre-service chemistry teachers (university students) and with chemistry teachers from practice. The aim was to identify which features of DATs are essential from the perspective of chemistry teachers and which from the perspective of their students. Furthermore, an attempt was made to define which DATs are suitable for individual phases of teaching or different educational purposes. Based on the previous quantitative survey, Kahoot, Google Forms, Quizizz, Socrative, Microsoft Forms, WordWall, and Plickers were selected as examples of various DATs usable in chemistry teaching for this study.

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ASSESSMENT OF INTERVENTIONS FOR SELF-EFFICACY IN ENVIRONMENTAL EDUCATION

Josef Šedlbauer & Jan Činčera

Abstract

One of the crucial tasks of environmental education is to equip students with self-efficacy and justified hope, in order to help them cope with environmental anxiety. The efficiency of two educational interventions in developing self-efficacy in university students undertaking the Environmental Science course was tested. Data were collected over two years. As part of the course, students articulated their environmental concerns. In the first year, students were assigned a seminar paper focusing on possible solutions to one of the issues they had listed. The following year, another group of students were asked to make a change in their lives (in terms of consumption, transport, housing or involvement in public life, for example) that would contribute to solving one of the environmental problems they had chosen. This change was documented for over two months and then presented. Environmental anxiety and self-efficacy were measured at the beginning and end of the course in both years. The results confirmed an increase in environmental anxiety as well as self-efficacy in both groups. These effects were more pronounced in the second year, suggesting a deeper emotional involvement when the intervention required students to step out of their comfort zones and connect with their own reality.

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THE "CHEMISTRY IN PRACTICE" SCIENCE WORKSHOP: BOOSTING PRACTICAL SKILLS AND FUTURE SCIENTIFIC CAREERS

SCIENCE WORKSHOP "CHEMIE V PRAXI": ROZVOJ PRAKTICKÝCH DOVEDNOSTÍ A PODPORA BUDOUCÍCH VĚDECKÝCH KARIÉR

Vladimír Maňas, Pavel Svozil & Radana Koudelíková

Abstract

School chemistry programs often suffer from a severe lack of practical tasks and hands-on lab experiments. Students rarely work with chemicals, which limits exposure to real-world chemistry and lowers their interest. To fix this gap and provide vital experience, we created the "Chemistry in Practice" Science Workshop, a special program helping talented students interested in science with experiences beyond classical school lessons. The workshop is hosted with the generous support of the Department of Inorganic Chemistry at the Faculty of Science, Palacky University Olomouc. It includes two courses for gifted students (elementary and high school). The program content integrates diverse approaches, including a chemical escape room, inquiry-based projects, and hands-on work with advanced scientific instruments. The overall goal is to ignite lasting interest and foster key scientific competencies. Crucially, increased motivation and positive attitudes toward chemistry raise the likelihood of students pursuing chemical careers. These courses expand student knowledge, giving them practical skills and direct guidance from experienced university teachers. Student feedback and program effectiveness were assessed using a detailed questionnaire; results will be discussed during this presentation. This project, supported by a grant from the Ministry of Education, Youth and Sports of the Czech Republic (MŠMT), has been run successfully with very positive feedback from the participants.

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OBSERVATIONAL SKILLS TEST: QUICK LOOK AT CZECH STUDENTS' RECOGNITION OF ORGANISM TRAITS

TEST OBSERVAČNÍCH DOVEDNOSTÍ: RYCHLÝ POHLED NA ROZPOZNÁVÁNÍ ZNAKŮ ORGANISMŮ ČESKÝMI STUDENTY

Filip Hašpl, Adam Nejedlý & Karel Vojíř

Abstract

The ability to use the scientific observation is a fundamental component of scientific literacy, and in the case of recognising and interpreting traits of organisms, it is an essential scientific skill in biology. Observation enables students to notice, interpret and distinguish between key diagnostic features of organisms. The Observational Skills Test (OST) was developed to assess students' ability to recognise and differentiate visual traits across various biological groups, including European fauna, flora, and microorganisms. The test was performed by 2017 Czech lower- and upper-secondary school students. Students achieved an average score of 19.6 out of 45, with a mean completion time of 15:43, and the best individual result reached 43 points. The results revealed a wide variability in performance, indicating that while some students demonstrated relatively strong observational skills, many struggled with identifying relevant morphological features. These outcomes may suggest that students have limited experience with structured scientific observation of organisms. The findings highlight the need to strengthen observation-based tasks in our schools.

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GENERAL SAFETY IN CHEMISTRY LABORATORY

BEZPEČNOST PRÁCE V LABORATOŘI

Iva Houdková & Miloslava Čeledová

Abstract

This teaching activity is intended as an introductory chemistry unit to make students familiar with the safety rules for laboratory. The aim of the activity is to address the fact that students often underestimate the risks associated with chemicals and that hazard symbols and safety principles are often perceived formally, without deeper understanding. During the activity, students examine four model situations from everyday life in which mistakes were made while working with chemicals – e.g., mixing up bottles, not using protective equipment, or not knowing first aid. They use visual clues (pictures, pictograms, excerpts from safety data sheets, etc.) for their analysis. From a methodological point of view, the activity uses station-based work, cooperative learning, and story analysis. The student group outcome is a creation of an information leaflet summarizing the rules of lab safe work. The last part of the activity is a reflection and analysis of the results. To verify the effect of the unit, a pre-/post-test focused on risk identification, understanding chemical pictograms and the ability to formulate safety principles was used followed by a questionnaire focused on students' attitudes towards the importance of following safety guidelines. The activity is tested on ~ 30 pupils and is expected to yield positive results i.e. better scores in the post-test compared to pre-test.

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ASSESSING THE PRIOR KNOWLEDGE OF PRE-SERVICE CHEMISTRY TEACHERS IN THE CONTEXT OF LABORATORY ACTIVITIES

TESTOVÁNÍ VSTUPNÍCH ZNALOSTÍ STUDUJÍCÍCH UČITELSTVÍ CHEMIE V KONTEXTU LABORATORNÍCH ČINNOSTÍ

Tadeáš Matěcha & Martin Rusek

Abstract

The paper presents results from a knowledge pretest and post-test evaluating the effect of a laboratory techniques course for pre-service chemistry teachers. The test consisted of multi-layered items assessing (1) recognition and use of laboratory glassware, (2) accuracy of measurement and data handling, (3) keeping laboratory records and interpreting phenomena, (4) laboratory safety and risk management, and (5) practical laboratory skills and optimization of procedures. For selected items, in addition to correctness, the level of response confidence and the quality of reasoning were also analysed. The data show a substantial improvement after completing the course, both in knowledge level and in confidence when responding. The most pronounced progress occurred in tasks requiring precise identification and use of laboratory equipment and in the ability to justify one's answers. Items requiring structured scientific notation and the formulation of safety principles also improved, although minor shortcomings in expression persisted. The overall increase in confidence across items indicates not only cognitive but also metacognitive gains from the course. The results underline the value of systematic laboratory instruction for fostering accurate experimental thinking and demonstrate the suitability of multi-layered tests for capturing not only knowledge but also students' reasoning and self-evaluation performance.

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DEVELOPING AND EVALUATING STE(A)M ACTIVITIES: OUTCOMES FROM THE ERASMUS+ PROJECT STEXPERIMENTS

TVORBA A OVEROVANIE STE(A)M AKTIVÍT V PROJEKTE STEXPERIMENTS: „KDY PŘESTANE SVÍČKA HOŘET?“

Karolína Mašková, Tadeáš Matěcha, Dominika Koperová & Martin Rusek

Abstract

This contribution presents results from the Erasmus+ project STExperiMents, which develops and tests hand- and virtual STE(A)M activities aimed at fostering inquiry-based learning and motivation in school education. The project unites partners from the Czech Republic, Austria, Finland, and Turkey to design, pilot, and evaluate eight innovative experiments. An adapted version of Intrinsic Motivation Inventory (IMI), supplemented with dimensions of cooperation, metacognition, and reflection, was used alongside an observation rubric and teacher interviews to evaluate the suggested experiments. Preliminary findings indicate that the combined use of quantitative and qualitative tools provides a nuanced understanding of students' engagement and teachers' perceptions of inquiry-based STE(A)M learning. The results support the use of simple but well-designed experiments as effective instruments for developing scientific literacy and positive attitudes toward science. The presented activity, "When Does the Candle Stop Burning?", illustrates how a simple everyday phenomenon can be used to develop scientific thinking, observation skills, and collaboration. Participants engage in all phases of the inquiry cycle — from hypothesis formulation to data interpretation — while experiencing meaningful learning and intrinsic motivation.

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AI IN SCIENCE EDUCATION: SHARING BEST PRACTICES

AI VE VÝUCE PŘÍRODOVĚDNÝCH PŘEDMĚTŮ: SDÍLENÍ DOBRÉ PRAXE

Monika Pelikánová

Abstract

The lecture will share examples of best practices in using generative artificial intelligence in science education and will focus on specific demonstrations that can be applied directly in teaching. It will present various ways of working with AI — from effectively structured instructional prompts and creating custom AI assistants to more advanced interactive features designed in Canvas (workspace) mode, such as intelligent worksheets, personalized tasks, learning simulations, or simple AI dashboards for managing students' learning. The session will include examples of activities tested in chemistry and biology lessons, demonstrations of their didactic use, and recommendations on how to integrate AI meaningfully and safely without technical complexity. The lecture is designed as a source of inspiration drawn from real classroom practice.

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MINI METEOROLOGICAL STATION AND ENVIRONMENTAL MEASUREMENTS WITH BBC MICRO:BIT AS INTERDISCIPLINARY STEM PROJECTS

Adam Lednár, Benjamín Kovács & Miroslav Šebo

Abstract

The paper presents two interdisciplinary STEM projects: a mini meteorological station and tasks focused on measuring water temperature and air humidity, both controlled by the BBC micro:bit microcontroller. The aim of the projects was to introduce environmental topics to primary school students within the framework of interdisciplinary education through digital technologies, programming, and working with sensors. While solving the tasks, students learned to collect and analyze data on temperature, humidity, and water levels, thus gaining practical experience with the use of sensors in real measurements. Questionnaire results showed that most respondents considered the programming and implementation of the meteorological station instructive and engaging, highlighting the development of analytical thinking and understanding the importance of environmental monitoring. Similarly, the tasks of measuring water temperature and air humidity were evaluated by students as practical and useful, as they enabled them to better understand the interconnection between natural phenomena and technology. The majority of respondents did not identify any significant problems when working with the microcontroller and appreciated teamwork. The projects proved to be an effective way to foster students' interest in STEM, develop digital competences, and strengthen environmental awareness through practical educational activities.

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DOES LAYOUT MATTER? A PILOT STUDY ON THE PRESENTATION OF ENVIRONMENTAL KNOWLEDGE

Blanka Dřevikovská, Pavel Teplý & Svatava Janoušková

Abstract

Environmental information design for lay audiences, incl. students, represents a critical intersection of environmental science and communication theory. Effective texts combine clear language, actionable content, emotional engagement, and accessible design to bridge the gap between expert knowledge and public understanding. These principles provide a framework for creating environmental communication that truly serves its intended audiences. However, successful implementation requires ongoing user testing, iterative refinement, and sustained commitment to accessibility and credibility. In our pilot study, we employed eye tracking to investigate how various text layouts affect users' ability to extract information and answer simple questions from a leaflet on global climate change. The information was presented both in textual form and through visual elements such as graphs and infographics. A pilot study showed that if we want readers to respond to questions, it's more effective to place the questions at the beginning of the text. Furthermore, it's advisable to state at the outset that the text, graph, and infographic convey the same information, enabling readers to select their preferred source for obtaining the answer. Nevertheless, according to think-aloud interviews, they would prefer to search for information directly in infographics or graphs.

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DEVELOPING STUDENTS' PLANNING SKILLS THROUGH INQUIRY-BASED LEARNING IN BIOLOGY

Adam Nejedlý & Karel Vojíř

Abstract

Planning skills are a fundamental component of scientific work. They enable students to think systematically about the individual steps of inquiry and to manage the process effectively. The ability to thoughtfully design a solution process in relation to specific research questions, identify variables, consider data collection tools, and plan the analysis of results is essential for developing students' scientific literacy. The aim of this research was to determine how inquiry-based tasks contribute to the development of scientific planning skills among lower secondary school students. Forty-five Czech students participated in the study, completing six inquiry-based tasks focused on biological topics. After each task, the students received feedback designed to support the development of their scientific planning skills.The analysis of the students' responses focused on five aspects of planning: inclusion of variables in the solution process, specification of the research sample, consideration of data collection tools, and planning of data processing and analysis. The results showed a positive trend in the gradual development of planning skills across the completed tasks. However, the progress of students' skills varied across individual aspects. The findings highlight which parts of the scientific research planning process require special attention in teaching and can help inform the design of targeted support.

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INNOVATIVE LEARNING WITHIN STEM: THE EDUCATIONAL POTENTIAL OF A TERRARIUM WITH THE AFRICAN SNAIL

Erik Krajinčák, Benjamín Kovács & Miroslav Šebo

Abstract

The aim of this paper is to present an innovative and empirically validated approach to STEM education through an interdisciplinary bio-terrarium project with the African giant snail. The project is grounded in constructivist pedagogy and experiential learning principles, integrating elements of biology, engineering, environmental education, and digital technologies. The educational process was designed as an applied research model with a focus on developing scientific literacy, systems thinking, experimental skills, and ecological awareness. Students actively participated in the design, construction, sensorization, and long-term monitoring of the terrarium habitat, employing methods of observation, measurement, and digital data analysis. This approach fostered critical thinking, the ability to formulate hypotheses, and the interpretation of empirical data. The project results indicate a high motivational, cognitive, and educational potential of using living organisms in STEM learning. Furthermore, they confirm the effectiveness of project-based and transdisciplinary learning models in fostering scientific competencies and environmental responsibility among students.

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PERSPECTIVES ON ARTIFICIAL INTELLIGENCE IN EDUCATION AMONG STUDENTS, PUPILS, AND TEACHERS – SELECTED FINDINGS

POHLED STUDENTŮ, ŽÁKŮ A UČITELŮ NA UMĚLOU INTELIGENCI VE VZDĚLÁVÁNÍ – VYBRANÉ VÝSLEDKY

Milada Teplá & Roman Maršálek

Abstract

The contribution presents the results of a broader study focused on attitudes, experiences, and ways of using artificial intelligence (AI) in education among three groups – university students, secondary school pupils, and teachers. The research combined a quantitative questionnaire survey (N = 957 students, 578 pupils, and 317 teachers) with a qualitative analysis of open-ended responses. The findings show that most respondents perceive AI as a useful supportive tool for learning, lesson preparation, and creative work, rather than as a replacement for their own thinking. At the same time, ethical uncertainties emerge, particularly concerning the boundary between legitimate support and unethical use. While pupils and students often operate in a "gray zone," teachers express a strong need for clear rules and methodological guidance. The study also reveals the psychological dimension of AI: some pupils and students use it as a source of emotional support or communication. Overall, the results provide insight into the current role of AI in Czech education and point to the need for systematic development of digital competences and ethical reflection across all levels of education.

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ARTIFICIAL INTELLIGENCE IN THE PREPARATION OF STUDENT TEACHERS OF SCIENCE AT MASARYK UNIVERSITY

UMĚLÁ INTELIGENCE V PŘÍPRAVĚ STUDENTŮ UČITELSTVÍ PŘÍRODOVĚDNÝCH PŘEDMĚTŮ NA MASARYKOVĚ UNIVERZITĚ

Veronika Švandová, Leoš Sáblík, Kateřina Klebanová & Patrik Pospíšil

Abstract

This contribution describes the implementation of AI in training chemistry student teachers at Masaryk University in the Czech Republic during spring 2024 and the year 2025. It explores student teachers' experiences with AI before and after taking the university courses "Teaching Materials in Chemistry" (for chemistry students) and "AI in tuition" (for students of science subjects). The research identified their areas of interest, desired skill development, and opinions on AI's inclusion in the courses and education overall. It also investigated how they used AI in their teaching practices. It covered AI tools like text generators (ChatGPT, Copilot, Gemini), graphics generators (Midjourney, DALL-E, Canva), lesson preparation applications (ScioBot), presentation applications (Gamma, Prezi AI), and digital assessment tools (Kahoot, Socrative, Quizizz / Wayground). Quantitative descriptive research was selected to gain initial insights into related issues. In the 2025 course, qualitative research tools were also used (a focus group).

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GEN AI AS A CO-DESIGNER OF PROJECT-BASED LEARNING PLANS: EVALUATING A SYSTEM PROMPT

GEN-AI JAKO ASISTENT UČITELE PŘI TVORBĚ PŘÍPRAV NA PROJEKTOVÉ VYUČOVÁNÍ: ANALÝZA FUNKČNOSTI SYSTÉMOVÉHO PROMPTU

Jan Válek & Nikola Straková

Abstract

The study presents and analyses the use of generative artificial intelligence (gen AI) to support teachers in preparing project-based learning (PBL) lessons. It focuses on a system prompt called Project Designer, designed to guide teachers dialogically and contextually in lesson planning based on the Gold Standard PBL model (Larmer et al., 2015). The prompt enables step-by-step project creation—from defining context and objectives to generating a full lesson plan—and integrates seven key PBL elements. The analysis examined two input types: vocational education topics and secondary school science. Each was evaluated by twelve criteria, including language adaptation, interactivity, creativity, comprehensiveness, structure, accuracy, and fulfilment of PBL principles. Results show that the prompt generates coherent and pedagogically sound project designs, with slight differences by subject: strong authenticity and relevance in vocational contexts, but weaker content anchoring in general subjects. The study also identifies recurring issues (e.g., overlong projects, limited student differentiation) and suggests ways to optimize the prompt for educational use. Overall, it highlights gen AI's potential not only as a tool but also as a didactic co-designer fostering creativity, reflection, and quality in project-based teaching.

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AI-SUPPORTED STRATEGIES FOR OVERCOMING CRITICAL POINTS IN THE TEACHING TOPIC NATURAL SUBSTANCES IN LOWER SECONDARY EDUCATION

AI-ASISTOVANÉ AKTIVIZAČNÍ STRATEGIE VE VÝUCE TÉMATU PŘÍRODNÍ LÁTKY V ZÁKLADNÍM VZDĚLÁVÁNÍ

Monika Pelikánová, Milan Šmídl, Jana Janovská & Martin Bílek

Abstract

This paper presents the results of an analysis of semi-structured interviews with chemistry teachers focused on identifying critical points in teaching Natural Substances at primary schools and lower grammar schools. The qualitative research revealed recurring problem areas in teaching proteins, fats, carbohydrates and vitamins, particularly difficulties connecting scientific terminology with everyday language, problems understanding abstract structural concepts, and insufficient linking of theoretical knowledge with students' daily lives. Building on the interview findings, we propose ways to overcome critical points using activation strategies based on artificial intelligence. Attention is given to creating didactically structured AI prompts that support content comprehension, develop student thinking, and enable learning differentiation. The paper further outlines the use of interactive AI tools and educational assistants to support active student engagement and independent work. The aim is to present a conceptual framework that connects the analysis of critical points in teaching Natural Substances in basic education with the design of innovative teaching interventions applicable in pedagogical practice.

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BALANCING CHEMICAL EQUATIONS AS A REFLECTION OF FIRST-YEAR CHEMISTRY TEACHER STUDENTS

VYČÍSLOVÁNÍ ROVNIC JAKO ZRCADLO STUDENTŮ PRVNÍCH ROČNÍKŮ UČITELSTVÍ CHEMIE

Dominika Koperová & Martin Rusek

Abstract

Balancing chemical equations remains a major challenge in chemistry education, reflecting students' conceptual understanding rather than mere procedural skill. This study examined how first-year pre-service chemistry teachers approach equation balancing as an indicator of their readiness for university-level chemistry. Test items targeted symbolic translation, understanding of stoichiometric principles, and reasoning confidence. Results show that while students can often balance equations mechanically, they struggle to connect symbolic notation with submicroscopic meaning and real chemical processes. Tasks requiring independent formulation or interpretation from verbal descriptions proved particularly demanding. The findings highlight the need to integrate conceptual, representational, and metacognitive dimensions of learning into teacher preparation, so that future educators can foster genuine understanding of chemical reactions in their own students.

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HOW TO TEACH STUDENTS SYSTEMATIC INQUIRY? A WORKSHOP USING GEOLOGICAL IDENTIFICATION KEYS

JAK UČIT ŽÁKY SYSTEMATICKY ZKOUMAT? WORKSHOP S GEOLOGICKÝMI URČOVACÍMI KLÍČI

Jakub Holec & Jakub Trubač

Abstract

This workshop is designed for lower- and upper-secondary school teachers. In the role of students, participants will try working with geological identification keys based on a decision tree. Using real samples, they will actively explore the characteristic properties of minerals, rocks, and fossils. The session will include reflection on how working with identification keys develops students' inquiry skills — observation, comparison, classification, logical reasoning, and independent investigation. Participants will also discuss how to effectively integrate this activity into lessons and what challenges students most often encounter when using identification keys.

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PROJECT LOESS: EDUCATION FOR SOIL LITERACY

PROJEKT LOESS: VZDELÁVANIE PRE PÔDNU GRAMOTNOSŤ

Marta Kuhnová & Júlia Karasová

Abstract

The presentation introduces the LOESS project (Literacy Boost Through an Operational Educational Ecosystem of Societal Actors on Soil Health), funded by Horizon Europe (Mission Soil), and its outputs designed for use in primary and secondary schools. The project offers a variety of educational tools, including a MOOC course, a mobile application about soil, an online Crowd Mapping Tool for assessing soil properties, and lesson plan suggestions. Participants will become familiar with practical approaches to soil literacy and learn how these tools can be integrated into school curricula to support students' understanding of soil health and sustainable land management.

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CHEMOPOLY: A DIDACTIC BOARD GAME FOR TEACHING CHEMISTRY AT PRIMARY SCHOOL

CHEMOPOLY: DIDAKTICKÁ DESKOVÁ HRA PRO VÝUKU CHEMIE NA ZÁKLADNÍ ŠKOLE

Veronika Jahodová

Abstract

Chemopoly is a new didactic board game focused on chemistry at the primary school level. It was developed as part of a bachelor's thesis at the Department of Chemistry and Chemistry Education, Faculty of Education, Charles University. The game is an analogue of the well-known Monopoly, adapted to the context of a school chemistry laboratory. A unique feature of Chemopoly is the inclusion of video recordings of school chemistry experiments from the eBedox database, which immerse students in the environment of a school laboratory because of their game achievements. The game incorporates selected topics from the primary school chemistry curriculum and can also be used in extracurricular activities or at home. It is suitable for inclusion in chemistry lessons at the beginning of secondary school to review and consolidate prior knowledge. Chemopoly not only helps to strengthen acquired knowledge but also enhances students' understanding of chemical concepts and processes. Furthermore, it promotes motivation to learn, cooperation, communication among classmates, and even the development of entrepreneurial thinking. The presentation will introduce the game's design, rules, and components, as well as its educational potential identified through initial testing and evaluation.

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