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Department of
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Research in Didactics of the Sciences



BOOK OF ABSTRACTS

PALACKÝ UNIVERSITY OLMOUC

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Plenary Lectures

REFORM OF POLISH CHEMISTRY CORE CURRICULUM: FUNDAMENTALS, GOALS, SOLUTIONS, AND OBSTACLES

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Abstract

We are living in a fast-changing world. Each year, new technologies become available, new social media appear, and we face new global challenges. It is not surprising that with a changing world, new generations of students enter schools. They have different life experiences, skills, habits, and expectations. Therefore, educational systems must keep up to date and adjust to new conditions. It is especially important for science subjects. In recent years, a decline in students' interest in the sciences has been observed across all educational levels. The number of students taking the chemistry matriculation examination (matura) over the past 10 years has decreased by one-third, and this decline cannot be attributed to demographic factors. Furthermore, the average score on the 2024 chemistry examination—38% (median: 33%)—further reinforces the perception of chemistry as a difficult school subject.

In 2025, the reform of the Polish educational system began. First at the primary school level, and next at secondary schools. Changes covered subjects taught, the number of science hours, the approach to science education, and students' learning. During the lecture, the main ideas of the new chemistry core curriculum for primary and secondary schools will be presented, together with a discussion of teaching aims, content, and learning organization.

Keywords

primary school; secondary school; chemistry; curriculum; reform

TRANSFORMING TEACHER EDUCATION FOR THE 21ST CENTURY: A FIVE-YEAR PROFESSIONAL PROGRAMME AND ITS COMPREHENSIVE EVALUATION

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Abstract

The presentation offers a conceptual and empirical reflection on innovation in pre-service teacher education, with a particular focus on science didactics. As of September 2026, the Faculty of Education at the University of South Bohemia in České Budějovice is implementing a five-year professionally oriented master's programme responding to curricular reform, societal change, and the need for deeper integration of subject-specific, pedagogical-psychological, and didactic components (Koldova, 2026).

A key premise of the model is the understanding of subject didactics as an integrative framework linking content knowledge, pedagogical competences, and experiential learning in authentic school settings. The programme is grounded in progressively structured reflective practice, ranging from assistant ones to a clinical semester during which students become members of a school's professional community.

The presentation introduces the research project Teacher Education 5P, which systematically evaluates this innovation. Using the CIPP model (Context, Input, Process, Product; Aziz, 2018; Stufflebeam, 2015), the project tracks students' competence development in alignment with the Graduate Teacher Competency Framework (MSMT, 2023). A comparison with the traditional model identifies benefits and limitations, particularly regarding didactic competence, self-efficacy, and readiness for contemporary science teaching.

Based on initial findings, the paper discusses the model's transformative potential within the European context. It highlights subject didactics as a bridge between theory and practice and emphasizes evidence-based approaches to quality assurance. Preliminary empirical results, including a SWOT analysis focused on science education, are presented. The presentation wants to stimulate discussion on whether systematically evaluated innovation in teacher education can strengthen science didactics and the professional identity of future teachers.

Keywords

teacher education; professional competences; teaching practice; CIPP model; subject didactics

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FROM AUTOCLAVE TO OVEN: MAPPING INTRODUCTORY LABORATORY COURSES IN CZECH CHEMISTRY TEACHER EDUCATION

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Abstract

Experimental activities are a foundational component of chemistry teacher education, shaping students' practical skills, safety habits, and understanding of experimental work. Although laboratory instruction has long been recognized as central to science education (Hofstein, 2004), the effects and conceptualization of introductory laboratory courses for preservice chemistry teachers remain underexplored. Moreover, available tools for assessing experimental activities in chemistry education are fragmented and often capture only selected aspects of laboratory work (Koperová, 2025).

This plenary presents findings from a national mapping of introductory laboratory technique courses in Czech chemistry teacher education. Course syllabi were analysed to identify declared aims, content, organization, and assessment approaches. Course coordinators from ten faculties preparing future chemistry teachers then completed an informative questionnaire, which served as a basis for follow-up semi-structured interviews focused on course conceptualization, students' laboratory work, task types, assessment practices, and expected learning outcomes. The findings show that, despite local organizational differences, introductory laboratory technique courses are conceptualized in a similar way across institutions. They commonly emphasize laboratory safety, basic laboratory procedures, practical skills, and preparation for subsequent laboratory courses. Differences mainly concern course scope, time allocation, organization, and implementation strategies, while declared aims are largely consistent. Assessment emerged as a comparatively underdeveloped component, often insufficiently reflecting the breadth of declared educational goals. The presentation will also discuss emerging findings on the effects of a laboratory course on students' perceptions of meaningful laboratory learning and the conative and affective dimensions of learning (Matěcha, under review).

Keywords

chemistry teacher education; laboratory technique; introductory laboratory courses; pre-service teachers; meaningful laboratory learning.

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Oral Communications

EMULSIONS THROUGH STUDENTS' EYES: EVALUATION OF INQUIRY-BASED LABORATORY ACTIVITY FOR K8-K12 STUDENTS

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Abstract

Inquiry-based learning should be effectively implemented in schools today. However, it is evident that we still need more ideas for activities and topics. Emulsions are fundamental components of our daily lives and can be found in various products, including groceries like milk, butter, mayonnaise, and vinaigrette, as well as cosmetics such as hair conditioners, cleansing milks, creams, and body lotions. Additionally, emulsions have significant roles in industry, appearing in medications, paints, and numerous other items. This wide range of applications provides an intriguing context for introducing dispersion systems in chemistry lessons.

While studying emulsions, students can observe the microscopic structure of a substance using an optical microscope, helping them directly connect it to its macroscopic properties and symbolic representation.

This article outlines a laboratory activity aimed at exploring how various factors—such as composition, emulsifier type, and preparation method—affect both the type and stability of emulsions. During this activity, students create a functional cosmetic: a moisturizing cream. This hands-on experience has been tested with 328 upper-secondary school students (K11), and its pedagogical effectiveness has been validated.

Keywords

high school; introductory chemistry; laboratory instruction, inquiry-based learning, colloids

Acknowledgement

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HISTORY OF CHEMISTRY AND BASIC CONCEPTS OF THE MICROWORLD IN LOWER SECONDARY SCHOOL CHEMISTRY TEXTBOOKS

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Abstract

In our previous work (Cídlová and Křivánková, 2014), we studied all available chemistry textbooks for lower secondary schools published in our country between 1945 and 2012 in terms of the occurrence of brief historical notes. In total, we analysed 48 textbooks. In the cited work, we classified the notes about history of chemistry found in the textbooks into ten categories (theories, laws, phenomena; obtaining substances; discoveries of substances; history of the names of substances; biographies; historical use of substances; longer overviews; fire; other facts; fictional content).

We are now analysing these data again, from a different and significantly more detailed perspective. Our aim is to determine which historical notes, in what way, and in which textbooks were used to introduce the basic concepts of the microworld, i.e., the concepts of atom, molecule, element, and compound. Historical notes and overviews are relatively often used as one of the common ways of introducing the concept of the atom, alongside analogies from everyday life, a gradual approach to the idea of very small objects, or the direct presentation of facts (Valová et al., in press).

Our work is part of a broader project focused on analysing the methods of introducing the basic concepts of the microworld from various perspectives.

Keywords

chemistry education; microworld concepts; history; textbooks

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TEACHING CHEMISTRY AND NATURAL SCIENCES IN HOME EDUCATION: THE EDUCATORS' PERSPECTIVE

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Abstract

Home education at the lower secondary level in the Czech Republic is increasing, reaching 2,553 students in the 2024/2025 academic year (ČSÚ, 2025). While parental motivations for homeschooling are widely documented (Kašparová, 2015, 2019; Kostelecká et al., 2023), the specific didactic challenges, including those in science education, that these families face remain underexplored. The educators are under no obligation to possess formal subject-matter or pedagogical qualifications. Within this framework, this study aims to map families' attitudes, approaches, barriers, and real needs regarding chemistry education at the lower secondary level. To explore and develop an explanatory model for this unexamined phenomenon, a qualitative research design based on Grounded Theory (Strauss & Corbin, 1999) was employed, gathering data through 12 in-depth, semi-structured interviews with parent-educators. The analysis reveals that educators' attitudes toward teaching chemistry are heterogeneous, spanning from anxious resignation to expert sovereignty. Despite strong general motivation, some parents experience a significant deficit in pedagogical content knowledge (PCK) in the exact sciences, which is the primary obstacle in home chemistry education. To mitigate this PCK deficit, parents frequently redefine their roles as educational managers. Depending on their level of PCK, parent-educators employ diverse instructional strategies, ranging from either verbal-theoretical textual reduction or extensive outsourcing via in-person or online tutors, to holistic, project-based instruction and structured inquiry-based learning. Notably, the findings also indicate that even expert parents can eventually succumb to "didactic fatigue" and regress toward purely theoretical teaching.

Keywords

home education; science education; chemistry teaching; pedagogical content knowledge

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FROM ANSWER TO UNDERSTANDING: EXPLORING CORRECTNESS, EXPLANATION, AND CERTAINTY IN CHEMICAL REPRESENTATION TASKS

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Abstract

This contribution follows our previous studies on first year pre-service chemistry teachers' ability to interact with non-textual components in chemistry study materials (Hamerská et al., 2025). It examines how first-year pre-service chemistry teachers work with chemical representations (Johnstone, 1991) and whether correct answers reflect scientifically justified understanding. The study involved 77 students from three Czech universities and used a four-tier diagnostic instrument (Putica, 2023) combining answer selection, explanation, confidence judgement, and familiarity. The tasks focused on three areas: macro–submicro transitions and working with symbolic and submicro representations.

The results show that students were substantially more successful in selecting correct answers than in providing scientifically adequate explanations. This diagnostic gap indicates that correct answers may mask weak conceptual understanding. The most accessible task involved a basic macro–submicro transition, whereas acid–base particle reasoning and some structural-representational tasks were more problematic. Confidence judgement provided additional insight: students' confidence in explanations reflected their actual performance better than confidence in answer selection.

Qualitative analysis of incorrect explanations revealed three broader weaknesses: surface reading of particle models, failure to coordinate multiple variables, and limited use of structural representations as reasoning tools. The findings suggest that representational competence is not purely item-specific and should be explicitly supported in chemistry teacher education

Keywords

chemistry education; representational competence; pre-service teachers; multi-tier test; misconceptions

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INTERNAL SPECIFICS OF SCIENTIFIC OBSERVATION IN BIOLOGY EDUCATION

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Abstract

Scientific observation is a core component of scientific literacy, yet it is rarely conceptualised and assessed as a distinct, measurable competence. This study investigates the internal structure of students' observational skills in biology and the relationships between their sub-components, with a particular focus on recognising diagnostic features and integrating them in more complex observational tasks. A large-scale quantitative dataset (N = 1,600 Czech lower- and upper-secondary students) was collected using the Observational Skills Test (OST), which distinguishes between feature recognition and more complex discrimination tasks. To examine the latent structure of observational skills, exploratory factor analysis using Principal Axis Factoring with oblique rotation was applied.

The results indicate the presence of a dominant general factor of observation, explaining a substantial portion of variance, suggesting that biological observation can be understood as a largely unified cognitive competence. However, the model also reveals considerable variability and weakly defined secondary factors, indicating that observational performance is highly context-dependent. Strong correlations were identified between feature recognition and more complex observational tasks ($r = .440$), as well as across biological domains ($r = .634-.690$), supporting the existence of a shared underlying skill. At the same time, differences in factor loadings and communalities point to domain-specific perceptual demands. These findings suggest that while observational skills have a general cognitive basis, their effective application depends on context and task characteristics. From an educational perspective, this highlights the need to explicitly develop both general observational strategies and domain-specific perceptual competencies in biology education.

Keywords

scient. observation; factor analysis; principal axis factoring; biology educ.; diagnostic features

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CHEMISTRY CALCULATIONS AND MATHEMATICAL SKILLS AT ISCED 2 LEVEL

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Abstract

Chemistry calculations have long represented a problematic area of chemistry education. Solving them requires not only knowledge of chemistry but also the application of mathematical skills, reading skills, the ability to connect knowledge across disciplines, and problem-solving skills (Rusek, 2022; Scott, 2012).

This contribution presents a quantitative study focused on chemistry calculations and mathematical skills at the ISCED 2 level. The research is based on data collected from 8th- and 9th-grade students at lower secondary schools. The study analyses students' overall success in solving chemistry calculations and mathematical tasks, the relationship between selected mathematical skills and success in chemistry calculations, and differences in success across various types of tasks.

Preliminary results indicate higher students' success in the mathematical tasks test compared to the chemistry calculations test, although both could be solved using the same procedure of calculation. In chemistry-oriented tasks, the highest success rates were observed in mass fraction, while the lowest were found in dilution problems. Consistent with findings from previous studies, the preliminary results do not suggest significant differences between symbolic and verbal task formats. However, initial qualitative observations indicate that students may apply different problem-solving strategies when solving mathematically similar tasks in chemistry and mathematics.

Keywords

chemistry calculations; mathematical skills; ISCED 2; lower secondary education; chemistry education

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CURRICULUM FOR INTEGRATED SCIENCE EDUCATION AT THE LOWER SECONDARY LEVEL – RESULTS OF A DELPHI STUDY

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Abstract

Current educational reform in the Czech Republic involves the development and verification of model school curricula aligned with the revised Framework Educational Programme for Basic Education. These curricula are intended to inspire schools in designing their own educational programmes and include subject-based, integrated, and thematic models. For the first time since schools were allowed to integrate educational content, concrete examples of curriculum integration are being developed, including in science education.

At the same time, little is known in the Czech context about which forms of science integration are preferred by experts and what content should be included in an integrated science curriculum. In this study, we analysed science curricula from countries applying an integrated “science” approach and identified the most frequently represented topics (Blaško et al., 2025). These topics were transformed into a questionnaire and evaluated by experts in a two-round Delphi study to determine which themes are considered essential for the Czech educational system.

The findings highlight several important issues. First, experts did not reach consensus on the most suitable approach to science integration. Second, chemistry received the lowest time allocation among all science disciplines. Respondents also proposed additional topics, indicating that some traditional chemistry and biology content—such as stoichiometric calculations, balancing chemical equations, and detailed knowledge of organisms (e.g., systematic botany and zoology)—would not be included in the integrated curriculum. These findings raise important questions about the future design of science curricula and suggest a need to reconsider traditionally taught topics that experts themselves may not regard as essential.

Keywords

integrated science education; curriculum; educational content of science disciplines

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REQUIREMENTS FOR TEACHERS AND THE COMPETENCIES OF STUDENTS TRAINING TO BECOME CHEMISTRY TEACHERS

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Abstract

Since 2025, an education reform has been underway in Poland, involving, amongst other things, changes to the core curriculum (Dz.U.). The ‘Graduate Profile’ for pre-schools and primary schools serves as the reference point for work on these documents (Szymczak, A., 2025). It has been decided that, alongside subject - specific knowledge and skills, the education process will foster cross-curricular competences and agency, so that future school leavers can make informed and rational decisions and find their way in a changing world. However, achieving these goals requires the use of a teaching model, that differs from the traditional one. In this new approach to teaching, the teacher is to act as a mentor, becoming someone, who not only imparts knowledge but also inspires development. Students, future chemistry teachers (participants in the Teacher Training Module) are being prepared to meet the requirements arising from the ongoing education reform. They are being trained to take on the role of a guide and to organise the teaching process in such a way that pupils discover knowledge for themselves. However, developing the skills in students, that are essential for achieving new educational objectives, faces many challenges. These stem from the students’ own experiences: as pupils in lower-level educational institutions, they were mainly exposed to a transmission-based model of teaching. In their work with pupils, they tend to replicate the practices they observed in their own former teachers. Furthermore, even if they are equipped with the necessary skills, during their teaching placements at schools they often replicate the working methods of the school teacher (placement supervisor) and fail to consolidate the competences they have learnt at university.

Keywords

teacher training, future chemistry teachers, education reform

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ZELENÁ CHEMIE A UDRŽITELNOST VE VÝUCE CHEMIE POHLEDEM BUDOUCÍCH UČITELŮ CHEMIE

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Abstract

Začleňování udržitelnosti do výuky chemie představuje aktuální výzvu chemického vzdělávání, neboť chemie umožňuje propojovat porozumění látkám, procesům a technologiím s environmentálními, sociálními i ekonomickými aspekty udržitelného rozvoje, včetně témat zelené chemie, šetrného využívání zdrojů a dopadů chemických procesů. Vzdělávání pro udržitelný rozvoj je chápáno jako průřezový koncept rozvíjející znalosti, dovednosti, postoje i kompetence potřebné pro řešení komplexních problémů dnešního světa (UNESCO, 2017; Bianchi, 2022).

Cílem příspěvku je představit, jak budoucí učitelé chemie vnímají priority začleňování témat zelené chemie a udržitelnosti do výuky chemie. Výzkum byl inspirován Q-metodologickým přístupem využitým při zkoumání prioritizace cílů udržitelného rozvoje u slovenských a českých učitelů (Kotuláková, 2025). Výzkumný soubor tvořilo 13 budoucích učitelů chemie, kteří třídili 48 výroků vztahujících se k environmentálním, sociálním a občanským aspektům udržitelnosti ve vzdělávání. Data byla zpracována v Ken-Q Analysis a extrahovány byly dva faktory.

Výsledky naznačují existenci dvou částečně odlišných, avšak souvisejících perspektiv. První akcentuje pluralitu přístupů k udržitelnosti, porozumění environmentálním souvislostem, klimatické změně, biodiverzitě, vodním zdrojům a vztahu mezi osobními potřebami a dopady na životní prostředí. Druhá klade větší důraz na občanské a institucionální rámce udržitelnosti, zejména na porozumění principům demokracie, právního státu, roli rozhodovacích orgánů a význam spolupráce. Obě perspektivy se shodují v důležitosti prostoru pro prezentaci a obhajobu názorů žáků, porozumění souvislosti mezi lidskou činností a klimatickou změnou a tématům zdraví, energie a biodiverzity. Výsledky otevírají diskusi o tom, jak v přípravě budoucích učitelů chemie rozvíjet obsahové porozumění udržitelnosti a zelené chemii i schopnost pracovat s hodnotovou pluralitou, systémovým myšlením a občanským rozměrem udržitelnosti.

Keywords

sustainability; chemistry education; pre-service chemistry teachers; Q-methodology

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DEVELOPING THE DIGITAL COMPETENCE OF PRE-SERVICE CHEMISTRY TEACHERS THROUGH E-TWINNING PROJECTS

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Abstract

The paper presents the results of a study focused on the development of digital competence through an eTwinning project in accordance with the European Framework for the Digital Competence of Educators (DigCompEdu). The research sample consisted of 30 pre-service chemistry teachers (with a combined second teaching subject) drawn from two partner universities, Pavol Jozef Šafárik University in Košice and Palacký University in Olomouc. The study was conducted during the autumn semester of the 2025/2026 academic year. A quasi-experimental one-group pre-test/post-test design was used. The intervention took the form of collaboration between the two partner universities within an eTwinning project, in which the students produced joint project outputs (e.g., laboratory protocols, summative assessment tasks, and formative assessment tools) and used digital tools for communication, collaboration, and the presentation of results (e.g., TwinSpace, Canva, and Padlet). The research instrument was a modified DigCompEdu Check-In Questionnaire (Redecker, 2017; Caena & Redecker, 2019), which the students completed before and after the project implementation. The results of the analysis indicate that the students' digital competence developed towards higher DigCompEdu framework levels, predominantly B2 (Expert) and partially C1 (Leader). With regard to professional engagement, the level of student cooperation and engagement increased primarily within collaborative online environments and the joint creation of digital materials. Their ability to search for and critically evaluate digital resources also improved, and the proportion of students able to create their own digital teaching materials increased. The overall results indicate that eTwinning projects have significant potential for developing the digital competence of pre-service teachers.

Keywords:

eTwinning; DigCompEdu; questionnaire, pre-service chemistry teachers

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WHAT HAPPENS IN THE LABORATORY BEYOND KNOWLEDGE? CONATIVE AND AFFECTIVE LEARNING EXPERIENCES IN PRAGUE AND DAVIS

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Abstract

Laboratory learning is increasingly understood as a multidimensional experience that cannot be captured by cognitive outcomes alone. Besides conceptual understanding, students' laboratory work involves affective experiences, competence beliefs, motivational regulation, perceived value, epistemic engagement and collaborative sense-making (Agustian, 2022; Galloway, 2015; Koperová, 2025). This study applies the Conative and Affective Learning in the Laboratory (CALIL) instrument to examine students' laboratory learning experiences in two higher education laboratory contexts: an introductory laboratory course for preservice chemistry teachers in Prague and a comparable introductory chemistry laboratory course at UC Davis. CALIL was administered in a pre–post design. After data cleaning, the analytic sample included 55 students from Prague and 73 students from Davis. The analysis focused on domain-level changes, reliability estimates and inter-domain relations. Wilcoxon signed-rank tests were used to examine pre–post differences, while correlation matrices were inspected to explore the structure of students' laboratory experiences. The results showed context-sensitive developmental patterns. In Prague, students reported significant increases in conceptual epistemic engagement and perception of time, alongside decreases in epistemic affect and extrinsic goal orientation. Negative emotions also increased, suggesting that the course may have made students more aware of the demands, uncertainty and time pressure of laboratory work. In contrast, the Davis sample showed largely stable profiles across domains, with no statistically significant pre–post changes. Across both contexts, correlations indicated strong interconnections between competence-related, epistemic, motivational and collaborative dimensions.

The findings suggest that CALIL can be used not only as a psychometric instrument, but also as a diagnostic tool for tracing how students experience laboratory learning over time. The study highlights the need to consider affective and conative dimensions when evaluating introductory laboratory courses and designing support for meaningful laboratory learning.

Keywords

chem. lab. education; affective learning; conative engagement; preservice chemistry teachers

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THE ABILITY OF PRE-SERVICE BIOLOGY TEACHERS TO EVALUATE THE SOLUTION OF INQUIRY-BASED TASKS

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Abstract

The ability to evaluate pupil work is one of the many skills that pre-service teachers should gradually acquire during their studies (Bořkovec, 2023). In this paper, we focus on assessing the proficiency of pre-service biology teachers (N=40) in evaluating selected solutions of inquiry-based tasks. The students were presented with 42 solutions of tasks focused on setting a goal and assessing its achievement, formulating a research question and answering it, formulating a hypothesis and evaluating it, and interpreting results and justifying them. Thematically, the tasks concerned the electrophoresis of proteins in animal milk and plant-based milk substitutes (Pavlasová, 2016; Pavlasová, 2017). The students' assessments of the tasks were subsequently compared with a so-called model assessment prepared by two educators of pre-service biology teachers. The overall average agreement between the students' and the model assessments was 59.4%, with large differences observed among students ranging from 7.1% to 76.2%. Based on these results, we believe that assessment training should be given attention in university teacher education, ideally using authentic pupil work from various age groups and across different instructional topics.

Keywords

pre-service biology teacher; didactics of biology; assesment

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GIVE THEM A CHANCE: CHEMISTRY FOR PUPILS OF SPECIAL PRIMARY SCHOOLS

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Abstract

Chemistry is often perceived as an abstract and inaccessible science, creating significant barriers for pupils with special educational needs (SEN). This contribution presents the initial stage of a research project focused on science education in special primary schools in the Olomouc Region, carried out by researchers from the Department of Inorganic Chemistry at the Faculty of Science, Palacký University Olomouc. The project aims to make chemistry more understandable, experiential, and accessible through the development of adapted teaching materials and practical learning activities tailored to pupils with SEN.

The project began with visits to special schools, consultations with teachers, and mapping of the current state of science education. In the first phase, a questionnaire survey involving 19 teachers from all contacted special schools in the region was conducted. The research focused on the organization of science teaching, material equipment, teaching resources, teachers' experiences, and the specific educational needs of pupils with SEN.

Over the past two years, the university department has also organized several interactive excursions for special schools, during which pupils participated in simple hands-on experiments and experiential activities. At the same time, university students completed teaching practice in these classrooms, gaining valuable experience with inclusive and inquiry-based science education.

The results revealed that the most significant barriers in science education include difficulties with understanding texts and instructions, problems with concentration, and limited opportunities for practical experiments. Teachers emphasized the importance of visual demonstrations, hands-on activities, and connecting scientific concepts with everyday life. The majority of schools reported insufficient laboratory equipment and a lack of modern teaching aids. Respondents expressed strong interest in new educational materials containing simplified texts, visual elements, worksheets, and interactive activities.

The findings will be used for the development of innovative instructional materials and methodological recommendations supporting inclusive science education. The project also strengthens cooperation between the university and educational practice while promoting experiential and applied learning for pupils with special educational needs.

Keywords

special educational needs; primary chemistry education

DYSLEXIA, CHEMISTRY AND MATHEMATICS

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Abstract

Dyslexia is probably the best-known specific learning disorder. It is often understood by the public as a reading disorder only, but it is a much more complex issue.

There are studies revealing that there is a widespread misconception among secondary school teachers that dyslexia does not affect the study of science subjects. For example, according to research conducted across 49 junior high schools in Greece (Passadelli et al., 2020), more than 90% of the teachers surveyed believed that dyslexia only affects students' performance in language learning.

Considerable attention is given to dyslexia in the academic literature; however, this literature mainly deals with its medical and psychological aspects or focuses on supporting pupils with dyslexia in reading and its practice. Among scientific educational texts, the effort to support language learning prevails, while natural science subjects in the context of dyslexia receive extremely little attention (Cídllová et al., 2024).

A precursor to reading skills and a generally accepted marker of dyslexia is a deficit in the area of RAN (Rapid Automatized Naming) (Carioti et al., 2022). It is this RAN deficit that is also emphasized in some studies as a common feature of both dyslexia and difficulties in elementary mathematics (Koponen et al., 2017). Our work examines the possible effects of RAN deficit on learning chemistry. We also aim to provide suggestions on how to support pupils in studying chemistry, taking the RAN deficit into account.

Keywords

chemistry education; mathematics education; dyslexia; rapid automatized naming (RAN).

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THE LIMITATIONS OF INFORMAL CHEMISTRY EDUCATION AS A BARRIER TO STUDENT MOTIVATION IN STUDYING CHEMISTRY

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Abstract

Non-formal (or informal) education is an organized learning process that takes place outside the traditional school system. It focuses on developing skills, attitudes, and competencies for everyday life. Unlike formal education, it is not mandatory and does not lead to the award of an official educational qualification; instead, participants choose programs voluntarily, according to their needs and motivation. A prerequisite for non-formal education is the participation of a qualified instructor, teacher, coach, or trained leader or instructor (*Neformální vzdělávání, MŠMT ČR, 2026*). Non-formal education is organized, for example, by various children's and youth clubs, non-profit organizations, children's and youth centers, educational agencies, or cultural institutions, and includes activities such as various clubs, special themed events, or camps, whether day camps or residential camps. Non-formal education is an important part of how individuals spend their free time and is particularly important for children and young people, as it enables them to develop skills in a wide variety of areas, often beyond the scope of formal education. It follows from the above that it is also very important for non-formal education to be implemented in as many areas of human activity as possible, and especially where society demands it. In this regard, it is well known that there is currently significant demand for experts in the natural sciences and technical fields, who are the drivers of the innovation necessary for economic growth and improving quality of life (Česká školní inspekce, 2025). Therefore, it is very important to prepare students for further study in these fields. Unfortunately, in the case of chemistry, as an important field of natural science, informal education is truly neglected. The cause of this unfortunate situation is that there are a significant number of legislative, technical, and personnel limitations to the implementation of informal chemistry education; another limitation is the current structure of formal primary chemistry education.

In this regard, this contribution addresses the aforementioned limitations in informal education and their impact on students' potential motivation to pursue further studies in chemistry and technically oriented fields. It further proposes possible approaches to implementing experimental instruction in particular, which could help minimize the aforementioned limitations. These proposals are based on many years of experience in implementing informal education in a framework of various activities of informal education.

Keywords

informal education, chemistry, education, barriers in informal education.

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GENERATIVE AI IN CHEMISTRY EDUCATION: DESIGN AND PILOT EVALUATION OF SPECIALIZED LEARNING ACTIVITIES

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Abstract

The rapid development of generative artificial intelligence (AI) creates new opportunities for designing educational activities that support active learning, inquiry-based approaches, and student engagement in science education (Bewersdorff et al., 2024). While large language models and conversational AI tools are increasingly entering educational settings, their implementation in chemistry education requires pedagogically grounded approaches and empirical verification of their educational potential.

This contribution presents the design and pilot verification of specialized AI-supported activities developed for chemistry education. The activities were designed to incorporate inquiry-oriented and narrative instructional principles while utilizing conversational AI as a scaffold for students' learning processes. Two specialized AI activities were created: Mixed-up Powders, focused on inquiry-based problem solving through virtual laboratory investigation, and Radioactivity – Stop Dr. V., employing narrative elements and scenario-based learning to support conceptual understanding and student engagement. In addition, a web application was developed to transfer selected simulation components into a more stable and user-friendly digital environment.

The proposed activities were pilot tested with pre-service chemistry teachers to explore their perceived usability, educational potential, and possible limitations in future teaching practice. Data collection focused on participants' reflections regarding clarity of task structure, perceived support for inquiry processes, engagement, and applicability within chemistry instruction. The pilot implementation provided insights into opportunities and challenges associated with integrating specialized AI tools into chemistry teacher education.

The findings contribute to ongoing discussions regarding the pedagogically meaningful integration of generative AI into science education and highlight the potential of specialized AI environments to support future teachers in developing digitally enriched instructional strategies.

Keywords

generative artificial intelligence; chemistry education; inquiry-based learning; pre-service teachers

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JAK STUDENTI POZORUJÍ A INTERPRETUJÍ CHEMICKÉ DEMONSTRACE: POROVNÁNÍ VIDEODEMONSTRACÍ A DEMONSTRACÍ PROVÁDĚNÝCH V REALITĚ

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Abstract

Chemické demonstrace umožňují studentům sledovat probíhající chemické děje v konkrétní experimentální situaci (Hofstein, 1982; Hofstein, 2004). Jejich přínos však nezávisí pouze na atraktivitě či nápadnosti pozorovaného průběhu, ale především na tom, zda studenti dokážou sledovaný děj propojit s jeho chemickou podstatou (Abrahams, 2008; Johnstone, 1991). Příspěvek představuje první studii disertačního výzkumu zaměřenou na porozumění studentů učitelství chemie při sledování videodemonstrací a demonstrací prováděných v realitě.

Výzkumu se zúčastnilo 22 studentů učitelství chemie, kteří po sledování vybraných demonstrací vyplňovali záznamové archy zaměřené na popis a interpretaci chemického děje a subjektivní hodnocení demonstrací. Sledována byla zejména zajímavost, názornost, souvislost s předchozím učivem a míra jistoty interpretace. Otevřené odpovědi byly hodnoceny podle referenčních popisů s cílem odlišit popis pozorovaného efektu od chemické interpretace. Výsledky ukazují, že studenti demonstrace často hodnotí jako zajímavé, názorné a motivační, zvláště pokud obsahují výrazné vizuální nebo smyslové efekty.

Tato pozitivní percepce však automaticky neznamená kvalitní interpretaci. Největší obtíže se objevují při přechodu od makroskopického popisu k chemickému vysvětlení: studenti často zachytí, že „unikal plyn“, „vznikaly bublinky“ nebo „změnila se barva“, ale obtížněji tyto jevy propojují s odpovídajícími chemickými koncepty.

Výsledky zároveň nenaznačují jednoznačnou převahu videodemonstrací ani reálných demonstrací; významnější se jeví konkrétní charakter demonstrace, její vazba na předchozí učivo a přehlednost pozorovaného děje. Na základě hodnocení odpovědí bylo vybráno 12 resp. pro navazující eye-trackingovou část studie: 4 úspěšní, 4 středně úspěšní a 4 neúspěšní řešitelé. Tito studenti absolvovali sledování 3 vybraných demonstrací s využitím eye-trackingu a retrospektivního think-aloud. V současnosti probíhá analýza vztahu mezi kvalitou interpretace, rozložením vizuální pozornosti a interpretačními strategiemi studentů (Tóthová, 2025).

Keywords

ch. demonstrace; videodemonstrace; porozumění ch. dějům; vizuální pozornost; eye-tracking

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DEVELOPMENT OF PROFESSIONAL VISION IN PRE-SERVICE CHEMISTRY TEACHERS THROUGH REFLECTION ON TEACHING SITUATIONS AND VIDEO ANALYSIS

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Abstract

The contribution focuses on the development of professional vision in pre-service chemistry teachers through reflection on teaching situations conducted within university-based teacher education. The study builds on research on professional vision, video analysis, and the development of reflective competences in teacher education (Gamoran Sherin, 2009; Pouta, 2021; Santagata, 2021). The aim of the study was to compare reflections written directly during teaching with reflections based on subsequent video analysis and to examine the development of reflective depth throughout the semester.

The research involved 10 pre-service chemistry teachers who prepared and implemented a total of 30 teaching situations focused on topics from general, inorganic, organic, analytical, and physical chemistry as well as biochemistry. Altogether, 242 reflections written directly during teaching and 270 video-based reflections were analyzed. The data were processed using qualitative content analysis. Individual reflective statements were coded according to thematic categories and evaluated using a five-level scale of reflective depth ranging from descriptive to professionally reflective interpretation.

The results indicate that repeated video analysis supports a shift from descriptive reflection focused primarily on formal aspects of teaching toward deeper didactic, subject-specific, and professionally reflective analysis. Compared with reflections written directly during teaching, students more frequently identified subject-specific errors, nonverbal communication, working with errors, and the impact of teaching on students' understanding after viewing the video recordings. The findings confirm the importance of video analysis as a significant tool for developing reflective competences and professional thinking in pre-service chemistry teachers.

Keywords

professional vision; reflective practice; video analysis; chemistry teacher education; reflection on teaching situations

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BIOLOGY EDUCATION STUDENTS' PERCEPTIONS OF THE GRADUAL DEVELOPMENT OF COMPETENCIES DURING TEACHING PRACTICE

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Abstract

The development of professional competencies in pre-service biology teacher education is increasingly framed by national competency frameworks and their subject-specific extensions (Vojíř et al., 2025). This contribution explores how biology student teachers perceive the gradual development of their competencies within a continuous practice model implemented at the Faculty of Education, Charles University. The model integrates regular school-based teaching with systematic reflection (cf. Korthagen, 2017; Loughran, 2006) and is structured around the gradual assumption of teaching responsibility – from observation to independent instruction—while linking practice to defined competencies. It is further grounded in the idea that professional learning emerges through the interaction of experience, reflection, and social support within authentic teaching contexts.

Data from biology student teachers (N = 41) indicate that the practice is perceived as beneficial for developing key competencies, especially in planning, teaching, and reflective practice. Students highlight reduced stress due to the distributed format, the importance of a supportive learning environment, and the value of reflective tools such as portfolios. They also emphasize the role of ongoing feedback and collaboration with mentor teachers in shaping their understanding of effective biology teaching. The findings suggest that a continuous practice effectively supports the structured and gradual development of subject-specific competencies in biology teacher education.

Keywords

teacher training; professional competencies; professional development; biology education

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Posters

POKUSNICE: MAKING CHEMISTRY EXPERIMENTS SAFE, SIMPLE, AND ACCESSIBLE

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Abstract

Teaching chemistry through experiments remains essential, yet it is often limited by safety concerns, lack of standardized procedures, and insufficient access to validated materials. This contribution presents Pokusnice, a web-based platform designed to support chemistry education by providing a structured, validated, and user-friendly database of experiments, chemicals, and laboratory equipment.

The platform integrates both pedagogical and technical aspects of experimental work. Each experiment is systematically described, safety-checked, and adapted for use in primary and secondary school environments. Special emphasis is placed on clarity, accessibility, and safe handling of chemicals. The system also includes visual documentation and supports mobile access, enabling flexible use in classroom and laboratory settings.

A key feature of Pokusnice is the ongoing validation process, which ensures the accuracy, relevance, and safety of all included experiments. The platform is further developed based on feedback from educators and testers, allowing iterative improvement and alignment with real educational needs. Additionally, the system incorporates tools for content management and licensing, supporting its scalability and sustainable use.

The presented solution aims to bridge the gap between theoretical instruction and practical experimentation, while reducing barriers for teachers and enhancing the overall quality of chemistry education.

Keywords

chemistry education; digital platform; laboratory experiments; safety; secondary education

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STEM THROUGH THE LENS OF CURRENT CURRICULUM REFORMS AND TEACHER EDUCATION

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Abstract

STEM education takes many different forms in recent decades, ranging from the integration of related school subjects through curricular and extracurricular activities—both formally and informally organized—to the application of various teaching methods and organizational structures, with a strong emphasis on thematic or project-based approaches. This also presents a major challenge for teacher education, pedagogical practice, and professional reflection. To support activities in this area, the International Centre for STEM Education (ICSE) was established in 2017 at the University of Education in Freiburg (Germany) (ICSE, 2024). As an international dimension of ICSE's activities, the foundation of an International Consortium for STEM Education was done in 2017, too. The ICSE Consortium comprises leading higher education and research institutions from across Europe, Charles University by Department of Chemistry and Chemistry Education of Faculty of Education including. The consortium was founded to foster cooperation and strengthen networks through various measures, such as joint research projects, newsletters, etc. One of current projects within the framework of the Erasmus+ program is “ICSE STE(A)M Vision – Empowering teachers as STE(A)M-visionaries: Co-creating systemic change across Europe through interdisciplinary multi-stakeholder collaboration” (ICSE STE(A)M Vision, 2026-2028).

Main objective is to create a sustainable interdisciplinary European partnership on integrated STEM that will provide a prospect on STEM teacher education. The achievement of this objective is planned through the following sub-objectives: (1) Improving STE(A)M teacher education by designing an effective STE(A)M teacher education programme in an interdisciplinary European co-creation process, (2) Making European mobility easily accessible for teachers by testing jointly a variety of formats and (3) Informing policy about STE(A)M teacher education and mobility in institutionalized exchange structures. The first steps of the project solving is co-creation process of modules for STEM teachers continuing professional development (CPD) and initial teachers education (ITE). Four clusters are planned: Sustainability, Digital Transformation, Food and Health and Societal Challenges. The authors is involved mainly in cluster Food and Health by co-creation of the module “Food in Controversial Position”.

Keywords

ICSE STE(A)M Vision Project; ICSE Consortium; STEM Education; STEM Teachers Education

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MODERN CHEMISTRY TEACHING THROUGH EXPERIMENTAL ACTIVITIES

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Abstract

Chemistry experiments represent a distinctive educational tool that enables students to connect observable phenomena with abstract chemical concepts and symbolic representations. In contemporary chemistry education, experimental activities should not serve solely as illustrative demonstrations but as cognitively meaningful tasks supporting conceptual understanding, scientific reasoning and inquiry-based learning.

The poster presentation focuses on the didactic role of demonstration and student-centred experiments in lower and upper secondary chemistry education within the framework of Inquiry-Based Science Education (IBSE). Particular attention is devoted to the potential of experimental activities to facilitate transitions between macroscopic observations, submicroscopic interpretations and symbolic representations, which constitute a fundamental challenge in chemistry learning.

Selected experimental tasks involving acid–base processes, adsorption phenomena, filtration, crystallisation, fluorescence and separation methods are analysed from the perspective of their educational objectives, cognitive demands and their capacity to support students' observation, hypothesis formation, interpretation of experimental evidence and scientific discussion. The contribution also reflects the role of teacher guidance in structuring inquiry-oriented activities and supporting meaningful interpretation of experimental outcomes.

The poster further addresses practical and methodological aspects of experimental chemistry teaching, including laboratory safety, organisational conditions and the accessibility of laboratory equipment in school practice. The presented approaches are based on practical experience from teacher education and professional development activities focused on innovative strategies in chemistry teaching.

The contribution emphasises the importance of transforming school laboratory activities from procedural tasks into educationally purposeful learning situations that foster deeper conceptual understanding and the development of scientific literacy in chemistry education.

Keywords

inquiry-Based Science Education (IBSE); scientific literacy; conceptual understanding

CURRENT STATE AND DEVELOPMENT PERSPECTIVES IN PRE-SERVICE TEACHER EDUCATION

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Abstract

Digital competence represents one of the key components of the professional profile of contemporary teachers, and its systematic development is an important part of pre-service teacher education. The aim of this study is to analyse the perspectives of university educators on the integration of digital competencies into pre-service teacher education and to identify the main challenges and opportunities for their further development. The research was conducted using a focus group discussion method, which enabled the identification of participants' experiences with the implementation of digital technologies in teacher education programmes. The analysis revealed that digital competencies are mainly developed within courses related to teacher education foundations and subject-specific didactics; however, their integration into curricula is often fragmented and lacks systematic implementation. Participants emphasized the need to strengthen practice-oriented learning, to connect digital technologies with subject didactics, and to expand curricular opportunities for developing digital skills of future teachers. The study's findings confirm that the key to success lies in integrating digital tools with a specific pedagogical context and didactic goals. The study was conducted within the framework of the VEGA project No. 1/0051/25 "Model for the Development of Digital Competencies of Future Science Teachers", whose partial objective is to analyse the current state of digital competence integration in teacher education programmes for science subjects and to identify possibilities for their systematic development within teacher education foundations and subject didactics.

Keywords

digital competence; teacher education; focus group discussion; science education; digital technologies

INTERDISCIPLINARY SCIENCE EDUCATION IN THE CONTEXT OF CURRICULUM REFORM: A COMPARISON OF INTERNATIONAL APPROACHES AND THE IMPLEMENTATION OF PEDAGOGICAL INNOVATIONS

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Abstract

Approaches to science education differ globally. We compared teaching models and analyzed when scientific disciplines are taught separately and how curricula differ across countries.

The analysis is based on international curriculum documents and comparisons of educational systems in countries representing diverse science education traditions. The results reveal four dominant models: (1) an integrated “Science” model, where all science content is taught together as a unified subject; (2) a transitional model, which combines integrated teaching with some early differentiation into separate subjects; (3) a model featuring early separation of subjects, in which biology, physics, and chemistry are taught as distinct courses from an earlier age; and (4) a phenomenon-oriented STEM model, where instruction is organized around interdisciplinary, real-world phenomena rather than traditional subjects.

The findings suggest that most countries use integrated science instruction at the primary level, with discipline differentiation most often occurring between the ages of 11 and 16. The most successful education systems combine the development of science literacy, inquiry skills, and conceptual understanding with a gradual deepening of knowledge in individual disciplines. These results not only inform the ongoing development and modernization of science education curricula but also lay a foundation for educational systems capable of preparing students to meet the evolving scientific challenges and opportunities of the 21st century.

Keywords

curriculum reform; integrated and separated subjects; interdisciplinarity; models of teaching; science education

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MINERAL WATER IN CHEMISTRY EDUCATION

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Abstract

The aim of this contribution was to analyse the topic from both an expert and didactic perspective, to design a set of teaching activities focused on mineral waters, and to verify their feasibility in school practice as well as their contribution to students' understanding of selected chemistry content.

Attention is to its possible inclusion in the Framework Educational Programmes and school curricula. Although mineral waters are not explicitly defined as an independent topic in Czech curricular documents, the analysis has shown that they can be meaningfully incorporated into several areas of chemistry teaching at lower-secondary and upper-secondary level.

The core part of research based on the design and school verification of six teaching activities connected with mineral waters, their properties, and their chemical analysis. These activities were implemented in different grades of a lower and upper secondary grammar school as well as in a chemistry seminar. The practical verification was conceived as a didactic validation of the proposed activities in an authentic school environment. Its main objective was to assess whether the activities are feasible in regular school conditions and whether they can contribute to a better understanding of selected chemistry concepts. Data were collected mainly through pre-tests and post-tests, by the analysis of students' answers, and pedagogical observation of the lessons. The results were evaluated predominantly qualitatively, in some cases supplemented by a simple comparison of the frequency of students' responses. The findings suggest that the proposed activities are applicable in school practice and that they can support students' understanding of selected topics, especially when the choice of activity corresponds to the students' age and prior knowledge. Simpler inquiry-based and observation activities proved suitable for younger students, while more demanding laboratory tasks were more appropriate for older students and seminar teaching.

Keywords

mineral water; design of teaching activities; validation of teaching activities

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COGNITIVE DIFFICULTY OF TASKS USING TEXT WORK IN BIOLOGY TEACHING: A VIEW INTO TEACHING PRACTICE

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Abstract

The paper focuses on the analysis of the cognitive demand of text-based learning tasks used during lower secondary biology classes. The study responds to the fact that previous research has primarily focused on the analysis of textbooks or test tasks, while less attention has been paid to tasks actually used in real classroom teaching. The research was conducted through non-participant direct classroom observation in seven 8th-grade classes at a lower secondary school in Prague. A total of 78 text-based learning tasks collected during 28 observed lessons were analysed. The tasks were classified using the revised Bloom's taxonomy and Tollingerová's taxonomy of learning tasks (Anderson et al., 2001; Tollingerová, 1986).

The results of the classification according to Bloom's taxonomy showed a predominance of tasks focused on lower-order thinking skills (LOTS = 82.1%), particularly remembering (37.2%) and understanding (30.8%). Higher-order thinking skills (HOTS = 17.9%) were represented less frequently. Tollingerová's taxonomy is conceptually structured differently; nevertheless, a higher proportion of tasks focused on lower cognitive levels was also identified using this taxonomy (LOTS = 68.0%; HOTS = 32.0%). The analysis further showed that cognitively more demanding tasks were more frequently associated with group work compared to individual pupil work. Text-based tasks were most frequently used during the fixation phase of the lesson, while they were not observed in motivational or diagnostic phases. The findings also indicate a predominance of reproductively oriented text-based tasks (83.1%) over productive tasks (16.9%) in the observed biology classes.

Keywords

biology education; text-based learning tasks; cognitive demand; Bloom's taxonomy; Tollingerová's taxonomy

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ANALYSIS OF STUDENT SELF-ASSESSMENT IN TEACHER EDUCATION PROGRAMS IN RELATION TO THEIR DIGITAL COMPETENCIES

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Abstract

The development of digital competencies has become one of the key challenges in teacher education due to the rapid digital transformation of education and the increasing role of AI in teaching and learning processes. Digital competence is currently understood not only as the technical use of digital tools, but also as their pedagogically meaningful and safe application in educational practice (Redecker, 2017). Previous studies indicate that pre-service teachers often demonstrate adequate operational digital skills, while competencies related to digital content creation, cybersecurity, and AI literacy remains insufficiently developed (Falloon, 2020; Ng, 2021, Sperling, 2024). The aim of the research was to analyse the level of digital competencies among students enrolled in teacher education programs at J. Selye University based on self-assessment and to identify the areas in which the most significant differences occur. The research was conducted using an online self-assessment questionnaire administered to 290 students enrolled in bachelor's, master's, and doctoral teacher educ. programs. The collected data were analysed using descriptive and correlational statistical methods. The results indicate that students' digital competencies are primarily oriented toward the use of traditional office applications, while competencies related to digital content creation, web design, cybersecurity, and artificial intelligence remain significantly underdeveloped. Most resp. evaluated their competencies at intermediate levels according to the DigCompEdu framework, particularly within levels B1–B2, whereas advanced levels (C1–C2) appeared only minimally. Significant differences were identified between bachelor's and master's students ($\chi^2 = 42.30$; $p = 0.003$), with master's students demonstrating higher levels of digital competencies. Participation in digital competence development courses also positively influenced students' competency levels ($\chi^2 = 7.57$; $p = 0.023$). The findings suggest that future teachers' digital competencies remain predominantly at the user level and insufficiently support innovative and pedagogically effective uses of digital technologies. The results highlight the need for systematic and practice-oriented development of digital competencies in teacher education programs, particularly in the areas of digital safety, digital content creation, and pedagogical applications of AI.

Keywords

Digital competence; teacher education; DigCompEdu; artificial intelligence; self-assessment"

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UTILIZATION OF MODELLING AND VISUALIZATION STRATEGIES IN SECONDARY SCHOOL CHEMISTRY EDUCATION

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Abstract

The teaching of science subjects in the Slovak education system faces many challenges and is undergoing a significant transformation, adapting to the challenges of modern education. Methodological studies emphasize that the use of experiential and interactive teaching in the classroom contributes significantly to maintaining students' interest and motivation, improves skills in conducting scientific tasks and proves that the connection of chemical phenomena to everyday life cannot be neglected (Korom & Purák, 2024; Irwanto, 2022). Digital tools are playing an increasingly important role in the education process, as teaching tools that appear in chemistry classes can not only be used for presentation purposes, but also increase student activity, and make chemistry classes a memorable experience coloured with measurement, modelling and simulation tasks (Irsai, 2024). The presented work has a dual goal. On the one hand, by an online survey, it examines the level of familiarity of chemistry teachers of Hungarian-language secondary schools of Slovakia, with the inquiry-oriented learning methods and their use in pedagogical practice, and also examines their attitudes towards visualization and modelling strategies. On the other hand, it analyses the acceptance of these methods by secondary school students through a questionnaire evaluation of an implemented chemistry lesson, which included inquiry-oriented learning methods, utilizing elements of visualization and digital molecular modelling. The emphasis was placed mainly on students' activity, their motivation, and the comprehensibility of the lesson, providing an insight into inquiry-oriented teaching approaches from both teachers' and students' perspectives.

Keywords

visualization; ICT-aided modelling; inquiry-based learning (IBL); chemistry didactics; STEM education

Acknowledgements

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OBSERVED PERFORMANCE VS. PERCEIVED PREPAREDNESS: ARE FIRST-YEAR CHEMISTRY STUDENTS READY FOR UNIVERSITY LABORATORIES?

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Abstract

Practical laboratory skills are a fundamental component of science education (Hofstein & Lunetta, 2004; Reid & Shah, 2007), and introductory university laboratory courses are typically designed with the expectation that students already possess basic laboratory competencies (Koudelíková et al., 2026). However, previous research has shown considerable variation in students' laboratory experience and confidence at the start of university studies (Mistry & Gorman, 2020). The actual level of students' preparedness is rarely assessed through direct observation. This study investigates the practical competence of first-year chemistry students by combining questionnaire data with observation of students performing a basic laboratory technique. The research was conducted at universities in the Czech Republic and Slovakia and focused on the relationship between students' prior experience, perceived preparedness, and actual performance. The findings indicate that students often consider themselves sufficiently prepared for laboratory work, while direct observation reveals substantial variation in the mastery of fundamental practical skills. The results highlight discrepancies between perceived and actual competence and emphasize the importance of assessing psychomotor skills alongside self-reported measures.

The study contributes to current discussions on the transition from secondary to higher education and provides evidence that may support the design of introductory laboratory courses and practical science education.

Keywords

laboratory skills; psychomotor skills; chemistry education; first-year students

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KNOWLEDGE, ATTITUDES, AND EXPERIENCES OF PUPILS AND STUDENTS WITH ADDICTIVE SUBSTANCES

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Abstract

This contribution focuses on the issue of addictive substances, which represents a complex health, social, and economic problem with a significant impact on the adolescent population. The core of investigation presents the results of quantitative research conducted via questionnaires among pupils and students at selected schools. The primary objective was to analyze the extent of pupils' personal experiences with legal and illegal substances, their motivation for use, and their perception of risks associated with specific substances. The research also focused on the availability of substances in the pupils' environment and the influence of the family setting. The findings confirmed high availability of alcohol in the respondents' surroundings (Kalina, 2015) and indicated a correlation between parents' smoking habits and their children's experience with nicotine. Data analysis (Gavora, 2010) revealed that despite relatively good awareness of the harmful effects of substances, the influence of peer groups and the immediate environment plays a crucial role in initial experimentation. The paper emphasizes the necessity of effective primary prevention in schools, which should reflect current trends in substance use and strengthen pupils' social skills to resist environmental pressure. The obtained data provide a view of the current situation and can serve as a basis for further development of preventive programs and pedagogical practice.

Keywords

addictive substances; addiction; prevention; adolescents; questionnaire survey

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FROM PLAY TO GAMIFICATION IN CHEMISTRY EDUCATION: A TWO-PERSPECTIVE MODEL AND THE LIMITS OF EDUCATIONAL ESCAPE GAMES

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Abstract

The concepts of play, didactic game, gamification, and educational escape game (EEG) are frequently conflated in both the scholarly literature and classroom practice, which complicates their pedagogically grounded selection in chemistry teaching. The paper offers a conceptual distinction based on six features of play derived from Huizinga (1949) and on the difference between structural and content gamification (Kapp, 2012).

The analytical core is an application of the model of Groß et al. (2023), which distinguishes a game perspective from a subject-matter perspective in EEG design. We argue that a chemistry EEG fulfils its educational function only when the subject-matter perspective dominates: each puzzle must purposefully develop a specific chemical concept or competence rather than merely serve as a narrative embellishment. We illustrate the argument by comparing two hypothetical escape games on electrolysis and by presenting a sample puzzle using acid-base indicators at the “apply” and “analyse” levels of the revised Bloom’s taxonomy.

In the critical section we draw attention to limits that tend to be overlooked in the enthusiastic discourse on gamification: the overjustification effect (Deci & Ryan, 1985), the time-cost of designing a high-quality EEG (10–40 hours), the risk of uneven student participation in heterogeneous classes, and the limited evidence for long-term knowledge retention (Veldkamp et al., 2020). The practical implication is the indispensability of a structured debriefing as a bridge between game-driven motivation and durable chemical understanding.

Keywords

gamification; educational escape game; chemistry education; Bloom’s taxonomy; motivation

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THE EVOLUTION OF THE CZECH EDUCATIONAL SYSTEM: HISTORICAL TRAJECTORIES, STRUCTURAL INEQUALITIES, AND THE POST-2027 REFORM ARCHITECTURE

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Abstract

The introduced poster presents the summary of the main ideas and conclusions of the critical scientific review *The Evolution of the Czech Educational System: Historical Trajectories, Structural Inequalities, and the Post-2027 Reform Architecture*.

The review describes the evolution of the Czech educational system from its Habsburg-era foundations through four decades of communist uniformity, post-1989 liberal transformation, and the current reform cycle embedded in the Czech Republic's Strategy for Education Policy until 2030+ (Strategy 2030+). Drawing on more than seventy peer-reviewed, governmental, and international institutional sources, the review offers a critical analysis of persistent structural failures which successive reform cycles have failed to resolve. It includes socioeconomic stratification amplified by early academic tracking in multi-year gymnasias, Roma educational segregation, early childhood education and care participation deficits, and chronic under-investment in teacher professionalization.

The post-2027 reform agenda, operationalized through mandatory implementation of revised Framework Education Programs and a landmark 2025 amendment to the Education Act, is evaluated against the available empirical evidence. The review concludes that while the current reform framework is among the most evidence-informed reform cycles in recent Czech educational policy, its efficacy will ultimately depend on political consistency, sustained financing, and a genuine transformation of classroom practice that has hitherto lagged behind legislative ambition.

Keywords

Czech Republic; educational reform; Strategy 2030+; early tracking; educational inequality; post-communist transformation

THE EFFECTIVENESS OF INTEGRATING DIGITAL RESOURCES IN ACCORDANCE WITH THE DIGCOMPEDU FRAMEWORK INTO PRE-SERVICE CHEMISTRY TEACHER EDUCATION

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Abstract

The rapid digitalisation of education has made the digital competence of pre-service teachers an important precondition for their professional preparedness, as well as their ability to respond to technological changes and adapt to current trends in education (Zhang, 2025). The DigCompEdu European Framework for the Digital Competence of Educators specifies six main areas of digital competence: Professional Engagement, Digital Resources, Teaching and Learning, Assessment, Empowering Learners, and Facilitating Learners' Digital Competence (Redecker, 2017). The research aimed to familiarise pre-service teachers with the possibilities of using digital resources in chemistry teaching and to promote the development of their digital competence with regard to the selection, creation, modification, and sharing of digital resources. The research sample consisted of first-year Master's degree students of chemistry teaching (N = 9) at the Faculty of Natural Sciences, Pavol Jozef Šafárik University in Košice. The intervention was carried out during the 2025/2026 academic year within the courses Activating Methods in Chemistry Teaching and Chemistry Didactics I, spanning 36 hours. Data were collected by means of a questionnaire developed by the authors based on the DigCompEdu framework. The questionnaire results indicated that the chemistry teaching students perceived the digital resources and tools used positively. The students identified the Viki platform, AI tools (ChatGPT, NotebookLM), PhET simulations, and an online teaching material database as the most useful, particularly for lesson preparation. The most frequently reported problems included technological limitations, language accessibility issues, difficulty navigating some platforms due to poor design, and the necessity to critically evaluate the accuracy of digital content and AI outputs. The students also identified working with digital resources and tools in the creation of learning tasks and digital tests covering selected chemistry topics at primary and secondary school level, as well as professional guidance provided by their teachers, as the most beneficial factors for the development of their digital competence.

Keywords:

digital competences; pre-service chemistry teachers; DigCompEdu; digital resources; chemistry education

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STEPPING INTO THE STORY: USING FIRST-PERSON VIDEOS AND AUTHENTIC NARRATIVES TO ENHANCE EDUCATIONAL ESCAPE ROOMS

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Abstract

Educational escape rooms have emerged as an innovative instructional approach that promotes active learning, collaboration, and the application of knowledge in authentic contexts (Veldkamp et al., 2020). Although increasingly implemented in science education, their educational potential can be further enhanced through the integration of immersive multimedia elements. This study focuses on improving educational escape rooms by incorporating first-person perspective videos, authentic photographs, real-world documents, and narratives inspired by actual events.

The design of the enhanced escape rooms is informed by inquiry-based science education (IBSE), encouraging students to solve scientific problems through guided inquiry rather than following predefined procedures (Pedaste et al., 2015). In addition, multimedia elements and visual scaffolding are incorporated in accordance with cognitive load theory and principles of multimedia learning (Mayer, 2021; Sweller et al., 2019) to support problem-solving while reducing unnecessary cognitive demands.

The aim of the study is to investigate whether these enhancements increase student engagement, motivation, and scientific literacy. In addition, the research examines the impact of multimedia-supported escape rooms on learners' understanding of tasks, problem-solving performance, and overall learning effectiveness. The study compares a traditional educational escape room with an enhanced version designed to provide a higher level of authenticity and immersion through multimedia and narrative elements.

Keywords

educational escape rooms; scientific literacy; multimedia learning; inquiry-based science education (IBSE)

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VISUALIZING THE NANOWORLD IN EDUCATION

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Abstract

Nanoscience, including nanochemistry and nanotechnology in general are rapidly developing fields of scientific research. Considering the future societal, environmental and economic impacts of these fields, there is a demand for an urgent need for development of nano education interventions (Bhukuvhani, 2013). In education the achievements of nanoscience present unique challenges due to the abstract and non-intuitive nature of objects and their phenomena at nanoscale. To overcome these difficulties, the incorporation of different methods and approaches into nano education are indispensable. This current study reviews Digital Technology-based (DT-based) approaches used for visualization of nanoworld in education. Particular emphasis was placed on presenting from real experiments through tangible visualization to interactive digital tools and augmented reality (AR) techniques. These approaches enhance deeper conceptual understanding, engagement, and accessibility, while also presenting new pedagogical challenges (Jones, 1986; Paivio, 2005). The integration of DT tools hold the potential for a more effective learning and understanding science.

Keywords

nanoscience; nano education; Digital Technology-based (DT-based) approaches; visualization

Acknowledgments

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WHEN “NATURAL” MEANS “SAFE”: EXPLORING STUDENTS’ RECOGNITION OF ARGUMENTATIVE FALLACIES RELATED TO HERBAL DRUGS AND MEDICINES

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Abstract

Socio-scientific issues related to herbal drugs and plant-based medicines represent a relevant context for argumentation and evaluation of scientific claims in science education. Students are frequently exposed to claims rooted in everyday beliefs, personal experiences, or misconceptions, particularly regarding the perceived safety and effectiveness of natural products. Such contexts may contribute to the emergence of problematic reasoning patterns and argumentative fallacies. The aim of this exploratory qualitative study was to investigate lower secondary students’ ability to identify, analyse, and critically evaluate problematic arguments related to herbal drugs and plant-based medicines. The study involved 24 eighth-grade students (aged 13-14 years) from a lower secondary school. The research instrument consisted of selected statements intentionally designed to contain argumentative fallacies and simplified reasoning patterns. Students were asked to identify the main idea of each statement, explain why the argument may be misleading or problematic, and formulate a counterargument. A total of 48 written argument analyses (two statements per student) were subjected to qualitative content analysis focusing on the identification of argumentative fallacies, reasoning patterns, levels of argumentation, and the quality of counterarguments. Preliminary findings suggest that students were generally able to recognise problematic reasoning patterns, particularly overgeneralisation, social normalization, and unsupported claims. While many responses demonstrated logical or evidence-oriented reasoning, the depth of argument analysis and the quality of counterarguments varied considerably, with only a smaller proportion of students constructing fully developed evidence-based counterarguments. The study aims to contribute to discussions on the role of socio-scientific issues in supporting argumentation and critical evaluation of claims in science education.

Keywords

argumentation; argumentative fallacies; critical thinking; science education; socio-scientific issues

ARTIFICIAL INTELLIGENCE AND STUDENT SCIENCE TEACHERS AT MASARYK UNIVERSITY

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Abstract

This contribution describes the implementation of artificial intelligence (AI) in chemistry student teachers' training at Masaryk University in the Czech Republic during springs 2024, 2025 and 2026. It explores student teachers' experiences with AI before and after taking the university courses "Teaching Materials in Chemistry" (for 17 chemistry students in 2024, 10 students in 2025 and 6 students in 2026). The research identified their experience with AI applications, 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 such as text generators (ChatGPT, Copilot, Gemini), graphic generators (Midjourney, DALL-E, ChatGPT, and Canva), lesson preparation applications (ScioBot, ChatGPT, Magic school, KhanMigo, Chalkie), 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 Teaching Materials in Chemistry course, a qualitative research tool was also used (a focus group). In 2025, most students used AI for lesson planning (compared to less than half in 2024) and designing chemical experiments. 2025 students lacked experience creating presentations with AI tools, so work with applications such as Gamma and Prezi AI was included in the course. All 2026 students lacked knowledge in the area of AI in copyright law and all of them wanted to teach about it. Preservice teachers play a crucial role in shaping the future of education and their willingness to incorporate AI into the classroom is paramount for their effectiveness as future educators (Sun, 2024).

Keywords

AI; chemistry; science; university students; student teachers

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THE HISTORY AND CURRENT STATE OF OZONE EXPERIMENTS AT THE DEPARTMENT OF CHEMISTRY UWB IN PILSEN

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Abstract

The first part of this contribution focuses on the development of an apparatus for the laboratory preparation of ozone at the Department of Chemistry, Faculty of Education, University of West Bohemia in Pilsen. This development dates back to the 1970s, when the first high-performance ozonizer was constructed as a modification of the classical Henne and Perilstein apparatus. This system represented a robust but technically demanding solution based on the use of a high-voltage source and an ozonization tube enabling ozone formation via a silent discharge. In the following decades, the design was gradually improved, with significant inspiration drawn from Klásek's ozonizer, which contributed to the development of simpler and more practical variants suitable for semi-micro techniques. Based on these approaches, further modifications were carried out, leading to an optimized apparatus that combines sufficient performance with increased safety and ease of operation. The current design consists of essential components including an oxygen source (typically compressed gas), flow meters for precise regulation, an ozonization tube, a high-voltage power supply, and an absorption vessel for capturing the generated ozone. A major transformation occurred in the high-voltage sources.

The second part of the contribution addresses the didactic use of ozone and the possibilities of incorporating this topic into chemistry education, particularly in laboratory courses. The didactic benefit lies not only in the development of experimental skills but also in understanding broader contexts, such as the role of ozone in environmental protection, its applications in technological processes, and its significance in the field of green technologies.

The third part of the contribution is conceived as an open section providing an overview of organic compounds that have been subjected to ozonolysis at the department in the past. It includes, in particular, derivatives of natural compounds, such as triterpenes like betulin, whose study has contributed to the elucidation of the structure and reactivity of unsaturated bonds. This section will be further expanded with specific experimental results and their significance both from the perspective of organic synthesis and chemical education, offering a comprehensive view of the long-term research focus of the department in the field of ozone chemistry.

Keywords

ozone; ozonizer; ozonolysis; triterpenes

Acknowledgement

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EDUCATIONAL MATERIALS THROUGH THE EYES OF EYETRACKING

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Abstract

It is well known that complex chemical tasks are often difficult for students because mathematical skills and focus on abstract chemical concepts are required (Johnstone, 1991). It is therefore appropriate to monitor the strategies students use to solve them to identify critical points in solving these tasks and propose effective teaching procedures to eliminate errors students make when solving them. To address this issue, this study investigates students' cognitive processes and strategies when solving complex chemistry-oriented tasks, combining eye tracking to monitor students' strategies and pupillometry, but not the underlying causes of behavior. Electrocardiography (ECG) (Kennedy, 2000) is also used to measure cognitive load, and Retrospective Think Aloud (RTA) protocols are used to study links between visual data from eye tracking, cognitive load, and conscious metacognitive processes (Holmqvist, 2011). The first results of the pilot show that the combination of the methods mentioned makes it possible to analyze the respondent strategies to solve tasks and to qualitatively monitor their cognitive load. It was identified that different strategies are used, based on their experience and knowledge of chemistry. One of the possible strategies was that the respondent did not consult the accompanying text to answer the question, because after reading it, he realized he could answer it without looking for information in it. Another strategy involves skipping the introductory text entirely, with the respondent focusing on the solution right from the start; if they realized they could answer without needing to read the introductory text, they did not read it at all. All the mentioned strategies, as well as other strategies used to solve the tasks and results related to cognitive load measurements, will be presented in a conference paper.

Keywords

eye-tracking; ECG; complex chemical tasks; high school students

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TABLE OF CONTENTS

PLENARY LECTURES

REFORM OF POLISH CHEMISTRY CORE CURRICULUM: FUNDAMENTALS, GOALS, SOLUTIONS, AND OBSTACLES Paweł Bernard, Mária Babinčáková	5
TRANSFORMING TEACHER EDUCATION FOR THE 21ST CENTURY: A FIVE-YEAR PROFESSIONAL PROGRAMME AND ITS COMPREHENSIVE EVALUATION Lukáš Rokos	6
FROM AUTOCLAVE TO OPEN: MAPPING INTRODUCTORY LABORATORY COURSES IN CZECH CHEMISTRY TEACHER EDUCATION Martin Rusek, Tadeáš Matěcha	7

ORAL COMMUNICATIONS

EMULSIONS THROUGH STUDENTS' EYES: EVALUATION OF INQUIRY-BASED LABORATORY ACTIVITY FOR K8-K12 STUDENTS Mária Babinčáková, Monika Brzostowicz, Elżbieta Szostak, Joanna Hetmańczyk, Paweł Bernard	9
HISTORY OF CHEMISTRY AND BASIC CONCEPTS OF THE MICROWORLD IN LOWER SECONDARY SCHOOL CHEMISTRY TEXTBOOKS Hana Cídllová, Petra Křivánková, Barbora Valová, Lubomír Prokeš	10
TEACHING CHEMISTRY AND NATURAL SCIENCES IN HOME EDUCATION: THE EDUCATORS' PERSPECTIVE Marcela Feltlová, Petr Šmejkal, Svatava Janoušková	11
FROM ANSWER TO UNDERSTANDING: EXPLORING CORRECTNESS, EXPLANATION, AND CERTAINTY IN CHEMICAL REPRESENTATION TASKS Lucie Hamerská, Tereza Tesárková, Martin Rusek	12
INTERNAL SPECIFICS OF SCIENTIFIC OBSERVATION IN BIOLOGY EDUCATION Filip Hašpl, Karel Vojř	13
CHEMISTRY CALCULATIONS AND MATHEMATICAL SKILLS AT ISCED 2 LEVEL Kristýna Havelková, Petr Šmejkal	14
CURRICULUM FOR INTEGRATED SCIENCE EDUCATION AT THE LOWER SECONDARY LEVEL – RESULTS OF A DELPHI STUDY Michal Blaško, Svatava Janoušková, Veronika Scholzová	15
REQUIREMENTS FOR TEACHERS AND THE COMPETENCIES OF STUDENTS TRAINING TO BECOME CHEMISTRY TEACHERS Bożena Karawajczyk	16
ZELENÁ CHEMIE A UDRŽITELNOST VE VÝUCE CHEMIE POHLEDEM BUDOUCÍCH UČITELŮ CHEMIE Dominika Koperová, Martin Rusek	17

DEVELOPING THE DIGITAL COMPETENCE OF PRE-SERVICE CHEMISTRY TEACHERS THROUGH E-TWINNING PROJECTS Petra Letošníková, Jana Prášilová	18
WHAT HAPPENS IN THE LABORATORY BEYOND KNOWLEDGE? CONATIVE AND AFFECTIVE LEARNING EXPERIENCES IN PRAGUE AND DAVIS Tadeáš Matěcha, Karel Štícha, Martin Rusek	19
THE ABILITY OF PRE-SERVICE BIOLOGY TEACHERS TO EVALUATE THE SOLUTION OF INQUIRY-BASED TASKS Lenka Pavlasová.....	20
GIVE THEM A CHANCE: CHEMISTRY FOR PUPILS OF SPECIAL PRIMARY SCHOOLS Kamila Petrželová, Slavomíra Šterbinská, Jana Prášilová, Vladimír Maňas, Peter Antal	21
DYSLEXIA, CHEMISTRY AND MATHEMATICS David Prokok, Hana Cídllová, Anna Bayerová.....	22
THE LIMITATIONS OF INFORMAL CHEMISTRY EDUCATION AS A BARRIER TO STUDENT MOTIVATION IN STUDYING CHEMISTRY Petr Šmejkal	23
GENERATIVE AI IN CHEMISTRY EDUCATION: DESIGN AND PILOT EVALUATION OF SPECIALIZED LEARNING ACTIVITIES Milada Teplá, Jiří Šumbera	24
JAK STUDENTI POZORUJÍ A INTERPRETUJÍ CHEMICKÉ DEMONSTRACE: POROVNÁNÍ VIDEODEMONSTRACÍ A DEMONSTRACÍ PROVÁDĚNÝCH V REALITĚ Tereza Tesárková, Martin Rusek.....	25
DEVELOPMENT OF PROFESSIONAL VISION IN PRE-SERVICE CHEMISTRY TEACHERS THROUGH REFLECTION ON TEACHING SITUATIONS AND VIDEO ANALYSIS Kateřina Trčková.....	26
BIOLOGY EDUCATION STUDENTS' PERCEPTIONS OF THE GRADUAL DEVELOPMENT OF COMPETENCIES DURING TEACHING PRACTICE Karel Vojří, Adam Nejedlý	27
 POSTERS	
POKUSNICE: MAKING CHEMISTRY EXPERIMENTS SAFE, SIMPLE, AND ACCESSIBLE Václav Bazgier, Jakub Juračka, Barbora Hubálková, Karel Berka	29
STEM THROUGH THE LENS OF CURRENT CURRICULUM REFORMS AND TEACHER EDUCATION Martin Bílek, Monika Pelikánová	30
MODERN CHEMISTRY TEACHING THROUGH Hana Doušová	31
CURRENT STATE AND DEVELOPMENT PERSPECTIVES IN PRE-SERVICE TEACHER EDUCATION Zoltán Fehér, Katarína Szarka, Ladislav Jaruska	32

INTERDISCIPLINARY SCIENCE EDUCATION IN THE CONTEXT OF CURRICULUM REFORM: A COMPARISON OF INTERNATIONAL APPROACHES AND THE IMPLEMENTATION OF PEDAGOGICAL INNOVATIONS Zuzana Haláková, Patrícia Szegedyová	33
MINERAL WATER IN CHEMISTRY EDUCATION Pavel Flosman, Jan Hrdlička, Dana Kričfaluši.....	34
COGNITIVE DIFFICULTY OF TASKS USING TEXT WORK IN BIOLOGY TEACHING: A VIEW INTO TEACHING PRACTICE Anastázie Janoudová, Lenka Pavlasová	35
ANALYSIS OF STUDENT SELF-ASSESSMENT IN TEACHER EDUCATION PROGRAMS IN RELATION TO THEIR DIGITAL COMPETENCIES Kinga Horváth, Ladislav Jaruska, Katarína Szarka, Péter Tóth, Zoltán Fehér, Attila Mészáros, Mária Ganajová.....	36
UTILIZATION OF MODELLING AND VISUALIZATION STRATEGIES IN SECONDARY SCHOOL CHEMISTRY EDUCATION György Juhász, Alexandra Hengerics Szabó, Barbara Ribná	37
OBSERVED PERFORMANCE VS. PERCEIVED PREPAREDNESS: ARE FIRST-YEAR CHEMISTRY STUDENTS READY FOR UNIVERSITY LABORATORIES? Radana Koudelíková, Iveta Bártová, Jana Chrappová, Pavel Štarha	38
KNOWLEDGE, ATTITUDES, AND EXPERIENCES OF PUPILS AND STUDENTS WITH ADDICTIVE SUBSTANCES Adam Kuchař, Jan Hrdlička, Alena Šrámová	39
FROM PLAY TO GAMIFICATION IN CHEMISTRY EDUCATION: A TWO-PERSPECTIVE MODEL AND THE LIMITS OF EDUCATIONAL ESCAPE GAMES Mária Orolínová, Katarína Kotuláková	40
THE EVOLUTION OF THE CZECH EDUCATIONAL SYSTEM: HISTORICAL TRAJECTORIES, STRUCTURAL INEQUALITIES, AND THE POST-2027 REFORM ARCHITECTURE Patrik Sokola, Patrik Pospíšil	41
THE EFFECTIVENESS OF INTEGRATING DIGITAL RESOURCES IN ACCORDANCE WITH THE DIGCOMPEDU FRAMEWORK INTO PRE-SERVICE CHEMISTRY TEACHER EDUCATION Mária Ganajová, Ivana Sotáková, Petra Letošníková.....	42
STEPPING INTO THE STORY: USING FIRST-PERSON VIDEOS AND AUTHENTIC NARRATIVES TO ENHANCE EDUCATIONAL ESCAPE ROOMS Pavel Svozil, Radana Koudelíková	43
VISUALIZING THE NANOWORLD IN EDUCATION Emese Kovács, Róbert Mészáros, Katarína Szarka.....	44
WHEN “NATURAL” MEANS “SAFE”: EXPLORING STUDENTS’ RECOGNITION OF ARGUMENTATIVE FALLACIES RELATED TO HERBAL DRUGS AND MEDICINES Patrícia Szegedyová, Zuzana Haláková	45
ARTIFICIAL INTELLIGENCE AND STUDENT SCIENCE TEACHERS AT MASARYK UNIVERSITY Veronika Švandová	46

THE HISTORY AND CURRENT STATE OF OZONE EXPERIMENTS AT THE DEPARTMENT OF CHEMISTRY UWB IN PILSEN	
Václav Richtř, Lukáš Vála, Daniel Vondřyska	47
EDUCATIONAL MATERIALS THROUGH THE EYES OF EYETRACKING	
Karolína Willimetz, Petr Šmejkal, Pavel Teplý	48

CONFERENCE PROGRAM

	Wednesday June 17		Thursday June 18		Friday June 19		
8:30			8:30-9:00	Tech. arrangement	8:30-9:00	Tech. arrangement	
9:00			9:00-12:10 Block 2	Plenary lecture M. Rusek, T. Matěcha	9:00-12:10 Block 4	Plenary lecture L. Rokos	
10:00				M. Teplá		F. Hašpl	
				K. Havelková		M. Babinčáková	
				Coffe break		Coffe break	
11:00				S. Janoušková		T. Matěcha	
				H. Cídllová		L. Pavlasová	
			L. Hamerská (Rusek)	T. Tesárková (Rusek)			
12:00					12:00-12:30	Closing Ceremony	
13:00	12:00-14:00	Registration	12:30-14:00	Lunch	12:30-13:30	Coffe break	
14:00	14:00-14:30	Opening Ceremony	14:00-15:20 Block 3	P. Šmejkal			
				M. Feltová			
15:00	14:30-17:40 Block 1	Plenary lecture P. Bernard		D. Prokop	15:30-17:30	Poster session + Coffe Break	
		D. Koperová		K. Petrželová, S. Šterbinská			
16:00		K Vojříř					
		Coffe break					
		B. Karawajczyk					
17:00	K. Trčková						
	P. Letošníková						
18:00	17:40-19:00	Visit to the Faculty of Science Visit to the Forst Science	17:30-19:30	City tour			
19:00							
20:00	19:00-22:00	Welcome drink	19:30-24:00	Social Dinner			
21:00							
22:00							
23:00							
0:00							

Thematic Sections:

- Plenary Lecture
- Preparation of Future Teachers
and Competences Development
- Curriculum, Innovation, and
Digital Technologies
- Inclusion, Special Needs, and
Alternative Forms of Education
- Teaching Methods, Research, and
Laboratory Activities



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