

International Conference
New Perspectives
**in Science
Education**
13th Edition

Conference Proceedings

13 March 2024, online event
14 - 15 March 2024, in Florence



Edited by



filo DAL 2008
diritto
editore

INTERNATIONAL CONFERENCE PROCEEDINGS

NEW PERSPECTIVES IN SCIENCE EDUCATION 13th Edition

**13 March 2024, Online Event
14-15 March 2024, in Florence**



Log in to find out all the titles of our catalogue
Follow Filodiritto Publisher on Facebook to learn about our new products

DOI: 10.26352/I314_2384-9509
ISBN 979-12-80225-58-0
ISSN 2384-9509

First Edition March 2024

© Copyright 2022 Filodiritto Publisher
filodirittoeditore.com
inFORomatica srl, Via Castiglione, 81, 40124 Bologna (Italy)
inforomatica.it
tel. 051 9843125 - Fax 051 9843529 - proceedings@filodiritto.com

Translation, total or partial adaptation, reproduction by any means (including films, microfilms, photocopies), as well as electronic storage, are reserved for all the countries. Photocopies for personal use of the reader can be made in the 15% limits for each volume upon payment to SIAE of the expected compensation as per the Art.68, commi 4 and 5, of the law 22 April 1941 n. 633. Photocopies used for purposes of professional, economic or commercial nature, or however for different needs from personal ones, can be carried out only after express authorization issued by CLEA Redi, Centro Licenze e Autorizzazione per le Riproduzioni Editoriali, Corso di Porta Romana, 108 - 20122 Milano.

e-mail: autorizzazioni@clearedi.org, sito web: www.clearedi.org

Publication Ethics and Malpractice Statement

The New Perspectives in Science Education Proceedings, edited by Pixel and published by Filodiritto Editore, is a collection of international peer reviewed Conference Proceedings committed to upholding the highest standards of publication ethics. In order to provide readers with Proceedings of highest quality we state the following principles of Publication Ethics and Malpractice Statement.

1) Editorial Board

Pixel, the Chief Editor, coordinates the Editorial Board whose members are recognized experts in the field of innovation in science education. The Editorial Board members are the experts involved in New Perspectives in Science Education Conference Scientific Committee. The full names and affiliations of the members of the Editorial Board/Scientific Committee are provided in the related section of the Conference Web Site. The Editorial Office is based at Pixel, Via Luigi Lanzi 12, I-50134 Firenze, Italy.

Email: science@pixel-online.net

2) Authors and Authors responsibilities

Authors are obliged to participate in the papers' peer review process, responding to the reviewers' feedback and making the requested corrections, retractions, modifications and/or integrations.

All authors must have significantly contributed to the research work for the paper's production providing real and authentic data.

Authors must have written original papers and are aware that it is forbidden to republish the same paper.

Authors must provide the list of references and disclose all sources of financial support.

Fees required for manuscript processing and publishing are stated on the Conference Registration page.

3) Peer-review process

Pixel, as the Chief Editor, ensures a fair double peer-review of the submitted papers for publication.

Peer-review is defined as obtaining advice on individual papers from reviewers' expert in the field.

Papers submitted to New Perspectives in Science Education Proceedings go through, first of all, an internal review and if they meet the basic requirements, they are sent out for review by experts in the field, who are members of New Perspectives in Science Education Scientific Committee. The Peer reviewers evaluate and give advice on the papers.

The paper review process is clearly described below.

The reviewers evaluate the submitted papers objectively and present their opinions on the works in the Review Form. Reviewers evaluate papers based on content without regard to ethnic origin, gender, sexual orientation, citizenship, religious belief or political philosophy of the authors. A reviewer who feels unqualified to review the research reported in a manuscript notify the Editor and excludes herself/himself from the review process.

The Chief Editor strives to prevent any potential conflict of interests between the author and the reviewers. Reviewers should identify relevant published work that has not been cited by the authors. If a reviewer finds any substantial similarity or overlap between the submitted manuscript and any other published works, she/he should inform the Chief Editor. Private information or ideas obtained through reviewing the paper must be kept confidential by the reviewers and not used for personal advantage. Papers received for review must be treated as confidential documents. Without any authorization by the Chief Editor, the information of the submitted paper must not be shown to, or discussed with, others.

4) Publication ethics

The Reviewers must report to the Chief Editor any identified plagiarism, research fabrication, falsification and improper use of humans or animals in research. The Chief Editor strives not to allow any misconduct.

In the event that there is documented misconduct the following sanctions will be applied:

- Immediate rejection of the infringing paper.
- Immediate rejection of every other paper submitted to in New Perspectives in

Science Education Proceedings by any of the authors of the infringing paper.

- Prohibition against all of the authors for any new submissions to New Perspectives in Science Education Proceedings, either individually or in combination with other authors of the infringing manuscript, as well as in combination with any other authors. This prohibition will be imposed for a minimum of three years.
- Prohibition against all of the authors from serving on the Editorial Board (Scientific Committee) of New Perspectives in Science Education Proceedings.

In cases where the violations of the above policies are found to be particularly outrageous, the Chief Editor reserves the right to impose additional sanctions beyond those described above.

Guidelines for retracting articles are the following:

- Retracting article will be considered if there is clear evidence that the findings are unreliable, either as a result of misconduct, honest error, plagiarism, or if the paper reports unethical research.
- The main purpose of retractions is to correct the literature and ensure its integrity.
- Notices of retraction will be promptly published on the online version of the Proceedings available on New Perspectives in Science Education Conference website and linked to the retracted article, accurately stating the information of the retracted article and the reason(s) for retraction.
- Articles may be retracted by their author(s) or by the Chief Editor (Pixel). The Chief Editor has the final decision about retracting articles. The Chief Editor will retract publications even if all or some of the authors refuse to retract the publication themselves in case of unethical behaviour.
- Authors who wish to enquire about publication of a correction for their article, or who have serious concern that they believe may warrant retraction, should contact the Chief Editor.

5) Copyright and Access

Copyright and licensing information is clearly described in New Perspectives in Science Education website at Release for Publication.

The electronic version of the Conference Proceedings will be shared to all the registered participants who paid the registration fee.

6) Archiving

New Perspectives in Science Education Proceedings books are digitally archived on **Google Scholar** and **Academia.edu**

7) Ownership and management

New Perspectives in Science Education Proceedings are managed and edited by Pixel and published by Filodiritto Editore.

8) Website

New Perspectives in Science Education Conference website demonstrates that care has been taken to ensure high ethical and professional standards. It does not contain any misleading information, including any attempt to mimic another journal/publisher's site.

9) Publishing schedule

New Perspectives in Science Education Conference Proceedings are published yearly.

10) Name of journal

The proceedings' name New Perspectives in Science Education is unique and cannot be easily confused with another journal. These proceedings have ISSN code from CNR.

Biomedical Science Education



Case/Problem-Based Learning in a Flipped Classroom and Under a Learning Contract as Didactic Tools for Collaborative Learning of Metabolic Regulation

Miguel Ángel Medina¹, Fernanda Suárez², Francisco José Alonso-Carrión³

University of Málaga, Spain^{1,2,3}

Abstract

It is a widely shared desire among most teachers of subjects in the area of biochemistry to achieve a relevant transfer of relevant knowledge to their students through an effective teaching-learning process. Many undergraduate students in biology, biochemistry and biomedical sciences find metabolism particularly difficult to learn. The very extensive contents of metabolic biochemistry and the need to integrate them in a way that gives them full biological meaning are essential causes of this difficulty appreciated by students. The transition from the traditional educational model focused on teaching to the EHEA (European Higher Education Area) model focused on learning and the acquisition of competencies by the student implies a change in the educational paradigm that makes it necessary to complement lectures with active methodologies that enhance the central role of the student in the learning process. Collaborative learning strategies can contribute to facilitate students' learning of metabolism, its regulation, and its biological integration. Among the active methodologies, case-, problem- and project-based learning methods, often developed under the "inverted" classroom model, stand out. These methodological tools and teaching strategies have been tested by the members of this educational innovation team as voluntary activities of continuous assessment under a learning contract in the framework of two subjects focused on metabolism and its regulation, in the second year of the Biology and Biochemistry Degrees at the University of Malaga. This communication will discuss these strategies, analyze their implementation and provide evidence of their impact on the teaching-learning process.

Keywords: Case/problem-based learning; flipped classroom; learning contract; metabolic regulation; collaborative learning



Popularization Strategies in Public Health Discourse: A Corpus-based Analysis in Portuguese and Chinese

Huanqi Sun¹, Katrin Herget², João Paulo Silvestre³

University of Aveiro, PhD candidate, Centre for Languages, Literatures and Cultures, Portugal¹

University of Aveiro, Centre for Languages, Literatures and Cultures, Portugal^{2,3}

Abstract

An increasing number of laypeople are turning to the vast information available on the Internet to self-educate in public health matters. For instance, they seek advice from experts in specific subject areas to understand how Covid-19 spreads or to clarify uncertainties about physiological reactions during pregnancy. Additionally, they actively engage in information exchange through magazines, websites, journalists, and other platforms on relevant topics. All of these efforts reflect laypeople's attempts to break down barriers in expert-layperson communication. In this context, the cultivation of scientific literacy emerges as a crucial skill, enabling individuals to critically assess scientific information and make informed decisions.

The vertical structure of medical discourse in Language for Specific Purposes (LSP) primarily distinguishes between internal communication and external discourse. External discourse, which is patient-oriented, involves doctor-patient interactions and communication with a broader audience [1]. The objective of discourse popularization is to ensure that scientific information becomes accessible to a wider audience. Therefore, it is imperative to adjust the language used based on the level of popularization required [2].

This paper explores strategies for popularizing scientific discourse in the field of public health in both Portuguese and Chinese, highlighting effective ways to enhance scientific literacy in these language communities. The corpus analysis is carried out using the corpus manager and text analysis tool, Sketch Engine [3].

Keywords: Public health, discourse, popularization, comparable corpora, strategies



Design of Inquiry-based Laboratory Projects for an Active Learning of (Bio)Chemistry, Focused-On Problem Solving in a Professional Setting

Ángel Luis García-Ponce¹, José Antonio Torres Vargas², Aurelio Moya-García³,
Melissa García Caballero⁴, Ana R. Quesada⁵

Universidad de Málaga, Andalucía Tech, Málaga, Spain^{1,2,3,4,5}

Abstract

Being aware that a change was needed in the style of laboratory teaching at our university our Educational Innovation Group TR4BIOCHEM (PIE22-067) is interested in the design and implementation of new inquiry-based laboratory activities, applicable to different subjects of the last courses of the degrees of the Faculty of Sciences. In this way, the learning process of disciplines such as biochemistry and analytical chemistry is transformed through a competency-based approach, making students to get more actively involved in their learning process, with the instructor as a mere "facilitator". Thus, many of these students have to face for the first-time issues that are common in a professional setting, such as the acquisition of reagents and materials, the assessment of the necessary instruments and equipment, the adaptation and scaling of experimental protocols, and the analysis of costs and operational feasibility, among others. This new approach motivates the students' interest, who being in the final phase of their studies, are particularly concerned about their upcoming incorporation into an increasingly demanding job market. This communication will present our experience from the last years at University of Malaga in the design and implementation of new teaching resources in which the hands-on laboratory work is just a part of a more complete sequence of learning activities.

Keywords: Problem-based learning, Laboratory experiments, Laboratory instruction, Hands-on learning, Bioanalytical chemistry, Undergraduate

Chemistry Education



Designing the Periodic Table Solitaire Mobile App

María José Cano-Iglesias¹, María del Mar López-Fernández², José Manuel Hierrezuelo-Osorio³, Antonio Joaquín Franco-Mariscal⁴

University of Málaga, Málaga, Spain^{1,2,3,4}

Abstract

The use of mobile applications in science education provides a series of benefits that enhance the learning experience and the understanding of scientific knowledge. Among these, interactivity, motivation, feedback, and personalized learning stand out. As part of a digital transition research project, mobile applications are being developed to enhance science teaching and learning. This study presents the design of the mobile app "Periodic Table Solitaire", whose objective is to familiarize users with the chemical elements of the Periodic Table, its structure, the families it comprises, and their relevance to daily life. This topic was chosen because the Periodic Table is an essential tool in chemistry, providing an organizational structure for chemical elements, aiding in understanding their properties, relationships, and behaviors. Various studies support that learning the Periodic Table through games yields educational benefits. "Periodic Table Solitaire" has been developed for Android using the Unity game engine and programmed in C#. The game's goal is to arrange all the cards into eight separate stacks, each corresponding to a family of the main groups (s and p-blocks) of the Periodic Table. The game features 43 cards, each representing the name and symbol of the chemical element, atomic number, group number, and an everyday object containing it (e.g., carbon in a pencil lead). All cards from the same family have a frame of the same color. Initially, the top of the screen displays eight spots for each family and a stack of covered cards. At the bottom of the screen, the cards are organized into six columns with one face-up card at the top of each column and one or more face-down cards below them. The player must move the cards between stacks and spaces to arrange them in ascending order by their atomic number. If the desired move is not possible, the player can uncover some of the face-down cards at the top of the screen. The game features various difficulty levels, each offering less information about the chemical element as the player progresses.

Keywords: Mobile app, Educational Game, Chemistry, Periodic Table, Solitaire Game



Building the Conceptual Profile of Chemical Analysis: The Sociocultural Domain

Maria Mavridi¹, Katerina Salta², Dionysios Koulougliotis³

Ionian University, Greece^{1,3}

National and Kapodistrian University of Athens, Greece²

Abstract

The conceptual profile framework is based on the assumption that people exhibit various modes of thinking that are used in various contexts. Chemical analysis is a central concept of chemistry and is characterized by a worthwhile polysemy, which is observed in both scientific and everyday language, such as the one employed in science classrooms. The purpose of this study is the development of the conceptual profile of chemical analysis, as a tool for characterizing the heterogeneity of students' ways of speaking and, therefore, thinking about it. The conceptual profile is composed of several zones. Each zone represents a specific way of thinking about the given concept and emerges from the study of this concept in different genetic domains. In the present study, the concept of chemical analysis is explored within the sociocultural genetic domain via examination of relevant secondary historical and epistemological literature. As a result, the following six conceptual profile zones which are related to the foundations of the concept of chemical analysis are proposed: chemical analysis as (a) everyday practices, (b) alchemist analysis, (c) empirical techniques, (d) classical analysis, (e) classical instrumental analysis and (f) a contemporary tool for society. Refinement and enrichment of the above proposed zones will follow by studying the ontogenetic and microgenetic domains of chemical analysis.

Keywords: conceptual profile, chemical analysis, sociocultural domain



An Investigation into the Pedagogy that Maltese Chemistry Teachers Adopt at Secondary School Level

James Borg

Saint Thomas More College Middle & Secondary School Żejtun, Malta

Abstract

This paper reviews the study carried out by Borg (2021) [1] which addresses an underexplored area of science education in Malta - the perspective of local secondary school educators on chemistry teaching. The study investigated the different pedagogical approaches used by Maltese Chemistry teachers at the secondary school level. Additionally, their views and attitudes towards teaching the subject were explored, including the opportunities and challenges encountered in the classroom. Student-centred (SC) pedagogies have been repeatedly linked with deeper learning and an improved interest in science. For example, Inquiry-Based Learning (IBL) actively engages students in the thinking and learning process through real-life tasks and problems. The Context-Based Approach (CBA) uses a real-life context as the starting point for the topic or lesson to orientate and motivate students and goes beyond providing examples as illustrations or applications [2]. These teaching methods do not only develop students' understanding but also enhance students' attitudes towards science [3]. As in other European countries, the chemistry curriculum and the pedagogical approaches used in the chemistry classroom in Malta are mainly traditional and limited to knowledge transmission [1],[4]. Moreover, the current chemistry syllabus at the secondary level (SEC) is abstract; one that promotes memorization and is not pertinent to students' everyday lives [1],[4]. A mixed methods research design was adopted during the study. An online survey and semi-structured individual interviews carried out with five different teachers from different schools were used to generate data. Results demonstrated that the teachers' methods of instruction are significantly influenced by their personal beliefs on teaching chemistry, as well as on how their pedagogical approaches affect their students' learning. Although the collected data showed evidence of teachers' knowledge and use of SC pedagogies, it was revealed that teacher-centred approaches remain widely used in the Maltese chemistry classroom. The Chemistry teachers were particularly concerned about the abstract and content-laden SEC Chemistry syllabus and the issue of assessment, where Malta's examination system mainly encourages educators to teach to the test.

Keywords: chemistry, secondary school, teachers, pedagogical approaches



The Impact of a M.Sc. Programme on the Career Paths of Postgraduate Students

Katerina Paschalidou¹, Katerina Salta²

National and Kapodistrian University of Athens, Greece^{1,2}

Abstract

The research study can provide important information for curriculum quality. A paradigm of curriculum evaluation describes the quality of an educational program as transformative. The present study concerns a three-semester Inter-Institutional Master of Science program in Chemistry Education, Information and Communication Technology and Education for Sustainable Development that is organized by the Department of Chemistry at the National and Kapodistrian University of Athens. The program aims at the professional development of postgraduate students and educates them in: (a) chemistry education research, (b) development new methods of teaching and assessment in chemistry, (c) connections between chemistry and chemical technology in everyday life, (d) development of education material using information and communication technologies, and (e) adoption of sustainable development goals in the teaching of chemistry. The present study describes an alumni online survey that assesses postgraduates' perceptions about the impact of the program on their career paths based on the transformative paradigm. Seventy (70) postgraduates from 2001 to 2022 responded. Although the low response rate of alumni which was mainly due to bad contact information, it has been suggested that the differences of the response rates do not affect the representativeness of the results. Overall, the program received positive feedback.

Keywords: Curriculum Evaluation, Professional Development, transformative quality



Bridging the Gap between School and University by a Laboratory Course on Functional Surfaces

Philipp Lanfermann¹, Christoph Weidmann², Thomas Waitz³

Georg-August-University Göttingen, Institute of Inorganic Chemistry, Department of Chemistry Education, Tammannstrasse 4, 37077 Göttingen, Germany^{1,2,3}

Abstract

The modification of surfaces for a specific change of material properties is a field of intense research, whereby the type of property change can be very diverse. Prominent examples are compact oxide layers that increase the corrosion resistance or generate colorful surfaces by interference effects. Additionally, porous surface layers enable the utilization of semiconductor or intercalation properties of the materials through major surface enlargement in order to make them applicable for solar cells or battery technologies. We developed a science camp held at the XLAB – Göttingen Experimental Laboratory for Young People providing school students with an experimental insight into this topic and the opportunity to explore the fascinating field of functional surfaces. The camp includes for example the functionalization of titanium through anodic oxidation, characterization by SEM at university facilities and experiments on novel battery technologies. Additionally, solar cells using titanium dioxide as semiconducting material are built and compared to silicon-based cells and novel perovskite solar cells developed by a collaborative research center at University of Göttingen (CRC 1073). We describe the concept of the camp and present an evaluation focusing on the learning progress of the participants on selected topics like semiconductor effects, mechanisms of oxide growth during anodic oxidation of titanium and the working principles of lithium or sodium-ion batteries.

Keywords: surfaces, nano structures, functionalization, science camp



Cyclic Voltammetry in Chemistry Classes

Vivian Keune¹, Erhard Irmer², Thomas Waitz¹

University of Göttingen, Institute of Inorganic Chemistry, Department of Chemistry Education, Germany¹

University of Göttingen, XLAB-Experimental laboratory for young people, Germany²

Abstract

Voltammetric methods have become an indispensable part of chemical research. Cyclic voltammetry (CV), in particular, is considered the most important method in the field of voltammetry [1]. Researchers use CV to determine redox properties, the number of electrons transferred or the reversibility of the reaction. CV also reveals information on the thermodynamics and kinetics of reactions as well as on underlying reaction mechanisms. Despite their great importance and diverse applications, voltammetric methods are rarely taught in school and teacher training courses. Likewise, previous literature and experiments mainly address graduate students and PhD candidates [2].

In this contribution, we present simple models and experiments to demonstrate that CV can easily be connected to the donor-acceptor principle and is well suited for repetition, application, consolidation and extension of relevant concepts of chemistry. Furthermore, the method offers the special opportunity not only to recognize the initial and final state of a redox process, but also to follow the course of electron transfer.

Our models and experiments help to make CV accessible to undergraduates and students at high school or school labs, providing a more detailed understanding of redox processes and the ability to observe them experimentally. In detail, we present teaching and learning materials students can use to investigate the reversibility of electrochemical reactions, using iron complexes and ascorbic acid. Additional experiments cover the determination of concentrations, redox potentials and the identification of chemical species. These topics are typically part of high school curricula and can be deepened in a more illustrative way by CV measurements. Finally, we present a first evaluation using CV materials in a teacher education lab course.

Keywords: cyclic voltammetry, donor-acceptor principle, model experiments



Transparent Inorganic Metal Oxide Solar Cells in Chemistry Class

Edwin Bogdan¹, Jan Fleischer², Thomas Waitz³

Georg-August-Universität Göttingen, Institute of Inorganic Chemistry, Department of Chemistry Education, Germany^{1,2,3}

Abstract

Due to the increasing challenges related to climate crisis and energy supply, the development of renewable energy sources is a major field of research and important for sustainable developments. In this context, solar cells play an important role and are already widely applied based on silicon. Nevertheless, silicon solar cells exhibit disadvantages such as a high energy demand in production and the requirement of highly pure raw material [1]. For these reasons, the working principle of silicon solar cells can only be discussed theoretically in chemistry classes, but their production under school conditions is not possible. Because of the disadvantages related to silicon solar cells, alternative solar cells like Grätzel cells [2] and perovskite solar cells [3] have already been subject in scientific research and can - in contrast to silicon solar cells - be easily built within a school lesson [4-5]. Furthermore, pure inorganic solar cells based on combined thin films of p- and n-semiconducting oxides of titanium and nickel have come into interest of researchers [6]. Being optically transparent and durable, their future integration as a photovoltaic active layer in windows is discussed, deposited by physical techniques like sputtering. For educational purposes, we developed a process to replace sputtering by facile sol-gel-syntheses which can be easily implemented in schools: After preparing a particle dispersion, thin films of two semiconducting metal oxides creating a heterojunction are applied on conductively coated glasses (FTO) with a self-built spin-coater assembled using low-cost components. In our contribution, we present experiments as well as teaching and learning materials covering topics from chemistry (sol-gel-synthesis) and physics (semiconductors) for upper secondary classes.

Keywords: solar cells, sol-gel-chemistry, renewable energies, education for sustainable development, curricular innovations



Nanomedicine: A Digital Learning Module for Chemistry Education

Antonia Fruntke¹, Nicolai ter Horst², Timm Wilke^{1*}

Carl von Ossietzky Universität Oldenburg, Institute for Chemistry,
Chemistry Education, 26129 Oldenburg, Germany¹
Friedrich Schiller Universität Jena, Institute for Inorganic and Analytical Chemistry,
Chemistry Education, 07743 Jena, Germany²

Abstract

The awarding of the Nobel Prizes in Chemistry and Medicine in 2023 is closely related to nanotechnology. Katalin Karikó and Drew Weissman received the prize in the medical field for fundamental research on mRNA vaccines against Covid-19, where the mRNA is encapsulated in lipid nanoparticles to prevent premature degradation by enzymes [1]. With this in mind, we present a way to convey this topic in chemistry education for schools and student labs. For this, we use the innovative method of a digital differentiation grid [2], and for the specific context, we focus on nanomedicine, or more precisely: targeted drug delivery. Conventional pharmaceutical drug systems usually have a systemic effect and cause severe side effects throughout the body due to the high doses applied. However, at the site of infection, the dose is often insufficient for successful treatment. This problem can be solved by using targeted drug delivery systems (DDS). Similar to mRNA vaccines, the active pharmaceutical ingredients are wrapped in nanoparticles and protected, thus preventing early release. The active ingredient is only released at the required location induced by pre-defined stimuli, such as pH or temperature. Within the learning module, various experiments and exercises about DDS are conducted, allowing students to gain insight into this current research topic [3]. The structure is based on a differentiation grid, enabling the topic to be approached individually depending on learning requirements [2]. Moreover, we use iPads and eBooks that include further digital elements to enhance students' motivation and engagement with the topic.

Keywords: nanotechnology, nanomedicine, medicine, drug delivery



Situational Interest in Medical Contexts for Chemistry Education: Construction of a Survey Instrument

Elisabeth Dietel^{1,2}, Timm Wilke²

Friedrich-Schiller-Universität Jena, Institute for Inorganic and Analytical Chemistry,
Chemistry Education Department, Germany¹

Carl von Ossietzky Universität Oldenburg, Institute for Chemistry,
Chemistry Education Department, Germany²

Abstract

Interest is an important asset for students' learning success and achievement. Even though teachers mostly cannot influence their students' individual interests, they can use interesting topics to stimulate situational interest in learning situations as a first step of interest genesis [1]. Creating contexts is one promising way to enhance personal relevance and everyday relations as triggers for situational interest. Using insights from different interest studies [2,3], medicine could represent a unique intersection of topics that seem interesting for young people of all gender. Besides their interestingness, medical aspects offer great overlaps with important curriculum contents in chemistry education. Despite the long-known potential of medicine as an interesting topic, it has only punctually been pursued further for usage in chemistry lessons away from few university level courses.

In this article, we present the process to narrow down the rather broad topic of "medicine" for chemistry education to create special medical contexts appropriate for different school levels, namely "breaking and healing bones", "blood circulation" and "wound dressings and closure". Further, we address the above-mentioned research gap by constructing a survey instrument for measuring situational interest in selected medical aspects that are directly connected with curriculum contents. All three contexts are joint together as the bigger theme "injury, blood and wounds". For measuring students' interest structures, we designed an online questionnaire based on studies concerning the interestingness of learning contexts in chemistry education [4] and consisting of three different parts: (1) analyzing individual interest in chemistry, (2) introducing students to our medical contexts using self-made videos, and (3) measuring the interestingness and the familiarity of the presented context as well as analyzing potential interest in learning using these contexts. Having analyzed the data from the pilot study of our questionnaire, we draw first conclusions on how interesting our contexts are for students and how to optimize the instrument for the main survey.

Keywords: *medicine, situational interest, context-based learning, situated expectancy-value theory*

Adapted Primary Literature about CO₂ Reduction Reaction – Chemists' Research Approach to Protect the Climate

Philipp Lanfermann¹, Marc Schrader², Thomas Waitz³, Mona Christin Maaß⁴

Georg-August-University Göttingen, Institute of Inorganic Chemistry, Department of Chemistry Education, Tammannstrasse 4, 37077 Göttingen, Germany^{1,2,3,4}

Abstract

European politics and society currently face enormous challenges, such as the energy crisis or the climate change. Research aims to contribute to possible solutions but unfortunately, research results are commonly only published to the scientific community, even though they might help politicians and society making decisions and acting responsibly. One approach to reach a broader audience is Adapted Primary Literature (APL) [1]: literature adapted from research articles and understandable to non-researchers. Herein, we present the conception and evaluation of an APL for high school students originating from a research article that follows the vision of using carbon dioxide as feedstock instead of fossil fuels [2]. This article presents a reaction path from carbon dioxide to carbon monoxide that could be converted into fuels like methane or basic chemicals for products of the chemical industry, such as plastics. The APL has the scientific style of writing and the characteristic sections of research articles: introduction, experimental methods, results, and discussion. High school students' gaps in knowledge about the experimental methods XRD, IR and NMR are closed by additional explanatory texts, whereas experimental details not relevant for high school students (e.g., measuring parameters) are omitted. The main results and the argumentation in the discussion part of the original article are mostly maintained to provide authentic insights into the scientific process of gaining knowledge. The evaluation of the APL revealed that around 20% of a test group of 30 high school students rated the APL as understandable, whereas no one in a control group of nine high school students indicated the translated original research article to be understandable. In addition, one in three of the 30 students showed interest in the APL, but only one in five in working with it in school lessons. Moreover, everybody in a group of ten prospective schoolteachers expressed the intention to use APLs in their future classes. In conclusion, the APL appears to be more understandable than the translated original research article, but there is still room for improvement in terms of understandability and interest.

Keywords: Adapted Primary Literature, CO₂ reduction



“The Complementary Structure of Deoxyribonucleic Acid” - Adapting the Crick and Watson Paper for Science Education

Hilko Aljets¹, Florian Heisig², Thomas Waitz³

University of Göttingen, Institute of Inorganic Chemistry, Department of Chemistry
Education, Germany^{1,2,3}

Abstract

It has been 70 years since the molecular structure of DNA has been decoded, which can be described as one of the most important scientific achievements of the last century. In 1953, Watson and Crick reported their double helix model in Nature, after Pauling and Corey had proposed a flawed three-stranded model. Later they gave a detailed description of the building of the model in a following article. Using this article in science education offers a wide range of valuable learning opportunities. In addition to the actual content of the highly interdisciplinary research, it allows students to learn about scientific model building and the use of models in research, as well as the development of scientific knowledge and nature of science. It can also be used as an example for a discussion on social influences on science, ethical considerations in science and good scientific practice. Due to the complexity of the original article, we propose to adapt the text so that it is also understandable for students. In this contribution, we report on our adaptation and the adaptation process, which is based on the concept of adapted scientific literature and suggest measures to unlock its potential for educational settings.

Keywords: adapted scientific literature, adapted primary literature, scientific literature, reading, DNA, historical case



University of Malta Courses with Intermediate / Advanced Chemistry as a Requirement and/or Option: An Analysis of Students' Choices

Edward Thake¹, Martin Musumeci²

St. Theresa College and San Ġorg Preca College, Malta¹
Department of Mathematics and Science Education, Faculty of Education, University of Malta, Malta²

Abstract

Tertiary course selection by post-secondary Chemistry students plays a pivotal role in shaping their academic trajectory across diverse fields [1]. Student decisions reflect a complex interplay of motivations and rationale, influencing not only their educational journey but also impacting curriculum design, pedagogical approaches, and support systems within Chemistry Education [2]. This study examines students' preferences, focusing on the University of Malta courses that have Intermediate (IM) or Advanced (AM) Chemistry as a requirement or option. Through distribution of self-administered questionnaires to stakeholders, this research study unveils themes derived from responses: influence, misconceptions, motivation, perception, career aspirations [3], acquired skills, and promotion of chemistry. [4] These themes shed light on converging and diverging viewpoints, offering insights into factors shaping students' decisions. Noteworthy results are student misconceptions about Chemistry, including perceiving it as difficult [5], underestimating its importance, and assuming limited career opportunities. The study underscores the significance of incorporating real-world applications of Chemistry in curriculum, advocating for practical examples, context-based approaches, and highlighting job opportunities to make the subject more relevant to students' daily lives. An often-overlooked aspect is the need for greater emphasis on promoting Chemistry as a standalone discipline. While Chemistry has served as a conduit to medical courses, its potential as an independent field is underappreciated, exacerbated by a lack of awareness and limited job opportunities. Consequently, students may explore alternative routes or consider options abroad [6]. The study reveals that having Chemistry at both IM and AM levels opens up a broader spectrum of career choices. University students highlight the role of personal aspirations and interests in motivating their decision to pursue a Chemistry-related course. While recognising factors such as University requirements, prestige, societal influences, and personal interests, sixth-form Chemistry teachers do not explicitly mention influence of personal aspirations in their key responses. Diverse career aspirations within the field of Chemistry emerge among University of Malta students. Despite this, there is a shared perception among university students that educational institutions inadequately promote Chemistry. These results could contribute to an informed and supportive framework for students navigating tertiary course choices in Chemistry.

Keywords: Chemistry; University Courses; Enrolment; Tertiary Education



Variation of the Synthesis for Influencing the Optical Properties of Carbon Quantum Dots

Malte Petersen¹, Timm Wilke^{1*}

Carl von Ossietzky Universität Oldenburg,
Institute for Chemistry, Chemistry Education Department,
26129 Oldenburg, Germany¹

Abstract

Quantum dots represent a novel and innovative class of nanomaterials, enabling precise adjustments in their absorption and emission properties. Their potential is evident in applications like phosphors and display technologies. The awarding of the Nobel Prize in Chemistry in 2023 has increased the general awareness of quantum dots, making the term familiar to many. From an educational standpoint, the introduction of these advancements into school curricula presents a valuable opportunity, allowing for the development of relevant experiments for educational purposes. The synthesis of zinc oxide quantum dots and carbon quantum dots is already achievable in educational settings.

In order to delve deeper into this subject, we suggest an alternative method of synthesis using a standard microwave. This method involves altering the ratios of reactants showcasing how these changes can influence the optical properties of the quantum dots. This approach not only highlights the important chemistry concept of structure-property relationships but also serves as an engaging introduction to the fields of spectroscopy and photochemistry.

Keywords: carbon quantum dots (CQDs), nanomaterial, optical properties, spectroscopy



Experimental Escape Games with Digital Enrichment - An Innovative Format in Science Education

Isabel Rubner¹, David Ditter², David Weiser³, Sarah Lukas⁴

University of Education Weingarten, Germany^{1,2,3,4}

Abstract

Escape games are innovative formats that are both motivating and have great potential to integrate subject-specific content and train future-oriented skills (21st century skills, future skills) in a fun and entertaining manner. Here, we present the integration of experimental escape games in chemistry education. They are carried out in the Chemistry Teaching and Learning Laboratory at the University Education Weingarten and developed further for the application in schools. The aim is to increase students' motivation for scientific topics and interest in STEM subjects, and to consolidate the application of knowledge acquired at school. In addition, 21st century skills (creativity, collaboration, interest, engagement and self-regulation) are promoted by embedding them in a game-based context.

In the escape games, experimental approaches and solutions are essential to achieve the goal. Some of the escape games are digitally enhanced and guide the students (e.g., Actionbound, H5P) or digitally enhanced with different technologies as needed (AR, explanatory videos, etc.). In this contribution, the development, testing and evaluation of this innovative teaching method is presented.

Keywords: game-based learning, Escape Games, Digitalisierung, STEM

Calculation Tasks' E-learning Methodology Creation and Application for Lower Chemistry Secondary Education

Andrejs Zaichenko¹, Mihails Gorskis², Martin Bilek³

Charles University, Czech Republic¹

Riga Technical University, Latvia²

Charles University, Czech Republic³

Abstract

Last 10 years Latvian national chemistry exam results have been researched and calculation tasks successful solution level downgrade tendency observed. Study author created an approach to help teachers in calculation tasks' solution teaching and training. E-learning methodology has been created based on Uzdevumi.lv platform's editor that provided virtually unlimited opportunity to individualise conditions, solve problems studying chemistry and organise competence tests. Effectiveness of methodology has been measured by a pedagogical experiment where 250 students from class 8 and 10 teachers with different pedagogical experience participated. Opportunities of ICT tools in performing calculation tasks' solving competence and checking results, principle of memorisation and basics of algorithms for calculation tasks have been researched. Main difference in methodology and using Uzdevumi.lv task editor compared with classical methods is the possibility to create calculation tasks with condition variations to increase diversity and individualised approach to each student. In the result chemistry calculation basic formulas have been combined with algorithms and numbers' randomisation allowed to create more than 1700 tasks with different conditions for the experimental group. Methodology has been tested and evaluated as recommended to use in Latvian schools to increase students' calculation tasks' solving skills in chemistry courses for lower chemistry secondary education level. Students' interest in e-learning platforms in chemistry lessons has been detected but nevertheless the majority believe that ICT and classic (printed tasks and communication with teacher) teaching tools should be used evenly.

Keywords: *ICT course, chemistry education, e-learning, methodology*

Curriculum Development



Integrating Artistic Research into German University of Applied Sciences Curricula: A New Paradigm in Science Education

Tobias Schmohl¹, Sebastian Grobler²

OWL Technical University of Applied Sciences and Arts, Germany^{1,2}

Abstract

This paper presents a pioneering approach to integrating artistic research into the curriculum of German universities of applied sciences (UAS). Recognizing the unique challenges and opportunities presented by artistic disciplines in higher education, we have developed modules for a master's program that blend epistemological content with the fundamentals of artistic research. This initiative addresses the current disparity in qualification opportunities for artistic disciplines at the UAS level, where artistic achievements are legally equated with scientific accomplishments, yet opportunities for higher qualification in these fields are limited.

Our approach is anchored in the belief that artistic research, a field that challenges traditional research paradigms by valuing artful knowledge alongside scientific knowledge, deserves a structured and recognized pathway within the academic system. Drawing from relevant legal texts and documents that equate artistic and scientific qualifications of personnel, we argue for the integration of artistic research into the curriculum as a step towards rectifying the existing imbalance and underrepresentation of artistic disciplines in higher education.

Keywords: *Artistic Research, Art-Based Research, Curriculum Development, Higher Education, Epistemology*

Educational Strategies



Disorders of Verbal Fluency in Individuals with Cognitive Dysfunctions from a Neuropsycholinguistic Perspective

Monika Betyna-Białek

Collegium Medicum, Nicolaus Copernicus University, Poland

Abstract

Language is the most important source of interpersonal communication. Therefore, studies on language functions are crucial in assessing various clinical groups, especially patients with cognitive function disorders. In patients in the early stages of dementia, there are numerous disturbances in verbal functions, including verbal fluency disorders. The analysis of verbal fluency in patients with different dysfunctions, such as damage to the right, left, or both hemispheres of the brain [1], has found application in the differential diagnosis of neurological disorders in children and adolescents [2], as well as in neuropsychological diagnostics [3], [4], [5] which has been systematically explored for several years. However, few studies on verbal fluency disorders in patients with cognitive impairments focus on comprehensive interdisciplinary neuropsycholinguistic analysis [6]. Therefore, it was decided to analyze the specifics of verbal fluency disorders in patients in the early stage of dementia, at the mild cognitive impairment stage, as well as in patients with clinical manifestations of dementia-related diseases. The aim of this research project is to examine and analyze verbal fluency in individuals with cognitive dysfunction at the level of mild cognitive impairment and dementia, including those with Alzheimer's disease. The results of verbal fluency test (MMSE) studies in patients showing similar disorders will be subjected to analysis. Using tools for corpus data analysis [7], [8], [9] the most frequently occurring words extracted from patient studies through the Mini-Mental State Examination (MMSE) scale for assessing mental status will be examined.

Keywords: verbal fluency tests, MMSE, functional disorders, cognitive disorders, corpus analysis



What Can Educational Case Studies Reveal About How Teachers Implement the Model of Educational Reconstruction in Biology Instruction?

Martin Jáč

Department of Biology, Faculty of Education, Palacký University Olomouc, Czech Republic

Abstract

The Model of Educational Reconstruction (MER) tightly links subject matter analysis and research on pupils' preconceptions to design the teaching and learning environments of school science subjects, including biology [1]. The paper will be focused on a qualitative analysis of how comprehensively biology teachers implement components of the Model of Educational Reconstruction into their lessons, i.e. whether they take advantage of pupils' preconceptions in designing instruction of different biology topics. The multiple-case study design with a theoretical replication was used in this study [2], together 18 individual case studies were included in the analysis. Each case study was based on a video record of a biology lesson and selected teaching and learning situations were qualitatively analyzed by 3A procedure (annotation – analysis – alteration), which enabled an in-depth assessment of the integrity of the instruction using the conceptual structure diagram [3]. Transcripts and conceptual structure diagrams of teaching and learning situations were analyzed using the principles of grounded theory and inductive approach [4] to identify and categorize components of MER and the level of its implementation in each educational case study. The multiple-case study results revealed several different levels of MER implementation into biology lessons ranging from solely diagnostics of pupils' preconceptions without their further use in the instruction to comprehensive use of MER in the design of teaching and learning environment in the analyzed lesson. The complex incorporation of MER into biology lessons with an emphasis on (re)construction of pupils' pre-scientific conceptions was very rare, as it was identified only in one educational case study. Particular examples of MER implementation into biology instruction will be highlighted in the paper.

Keywords: biology instruction, educational case study, Model of Educational Reconstruction, biology teacher



The Energy Blackout in Debate. An Activity to Develop Argumentation in Pre-Service Primary Teachers

José Manuel Hierrezuelo-Osorio¹, María José Cano-Iglesias², María del Mar López-Fernández³, Antonio Joaquín Franco-Mariscal⁴

University of Málaga, Málaga, Spain^{1,2,3,4}

Abstract

Society increasingly requires citizens with reflective and critical thinking skills to navigate challenges arising from scientific and technological advancements. Developing argumentation skills, crucial for personal, social, and professional life, is an important educational objective. Focusing on pre-service teacher education brings benefits, enabling critical analysis of pedagogical theories, educational practices, and research findings. Debates emerge as a highly relevant strategy within this educational context, fostering important processes, such as making informed decisions, mainly through evidence-based argumentation, for students' intellectual and civic development, which is important for building an informed and engaged citizenry in a democratic society. This paper delves into how pre-service teachers argue about Science, Technology, and Society (STS) issues, setting the stage for mobile applications addressing environmental concerns to advance digitalisation and sustainability in education. The study introduces a "Microdebate" activity involving pre-service primary education teachers in a brief debate on the possibility of an energy blackout in Europe. The activity unfolds in four phases: initial decision-making, debate preparation, staging the debate, and final decision-making. Analysing the initial decision-making revealed a majority favouring an energy blackout, citing arguments such as excessive energy resource use and political factors, with a significant portion offering conclusions without justified arguments. A notable shift occurred in the final decision-making, with the majority now against, primarily citing negative energetic consequences. Environmental considerations also emerged prominently. Notably, there was a significant reduction in students not providing justifications post-activity, indicating the potential of debate to enhance argumentation skills. These preliminary results will inform the design of mobile applications focused on arguing about environmental actions.

Keywords: Pre-service teachers, argumentation, decision-making, debate, educational strategies



Go Extinct! The Educational Game for Learning about Invertebrates

María del Mar López-Fernández¹, José Manuel Hierrezuelo-Osorio², María José Cano-Iglesias³, Antonio Joaquín Franco-Mariscal⁴

University of Málaga, Spain^{1,2,3,4}

Abstract

Educational games offer a multitude of advantages in the teaching process, including enhancing motivation, active learning, fostering collaboration, skill development, immediate feedback, practical application of knowledge, adaptability, stress reduction, promotion of creativity, memory improvement, and retention. These attributes render games as effective tools for engaging students, facilitating understanding and learning, as well as promoting both social and cognitive skills. Nevertheless, their effectiveness hinges on their seamless integration into the curriculum, along with a careful consideration of students' needs and age [1] [2]. In this study, we present an educational game entitled "Go Extinct!" designed to teach students about invertebrates. The game comprises a deck of 16 cards, each featuring illustrations of invertebrates from various taxonomic groups. At the outset, four cards are randomly distributed to each player. In each round, players discard one of their cards and pass it to the player on their right. The objective of the game is to extinguish an entire invertebrate group by collecting four cards from the same taxonomic category. The first player to achieve this and announce the invertebrate group's name wins the game. We implemented this game with 42 eighth-grade students (aged 11-12) who were studying biology in a high school in Spain as part of their invertebrate module. After the game, the students completed a [8] in which they assessed the activity and its impact on their learning. In terms of evaluating their learning, students rated their initial knowledge at 4.69 out of 10, which increased to 7.98 after the activity, indicating an improvement of 3.29 points. The game received high ratings, with 70% finding it very easy, 77% deeming it very useful, 67% describing it as highly attractive, and 81% considering it very interesting. Overall, the students rated the game at 9.1 out of 10. The results from this study seem to suggest that the educational game "Go Extinct!" effectively promotes the understanding of invertebrate groups among Spanish eighth-grade biology students. Additionally, it has positively influenced motivation, generated interest, and increased student participation. Building on these promising findings, our future plans include digitizing the game and subjecting it to evaluation using e-rubrics.

Keywords: Game-Based Learning, Invertebrates, Science Education



Active Learning for Circular Economy Businesses, Fostering a Sustainable Mindset

Sabrina Fontanella¹, Giovanna Attanasio², Luca Fraccascia^{1,3}, Fabio Nonino¹,
Cinzia Battistella²

Sapienza University of Rome, Italy¹
University of Udine, Italy²
University of Twente, The Netherlands³

Abstract

Despite extensive literature on corporate sustainability, understanding how companies become sustainable remains elusive. Similarly, the innovative processes that lead organizations to become “green” are not well understood. Industrial symbiosis (IS) offers a new model for sustainable development, involving the exchange of waste materials between companies. This study explores how IS can be taught to students to develop sustainable entrepreneurial skills, using a business game developed for the “Circular Sustainable Business Development” course at the University of Twente. The game allows students to negotiate simulated IS agreements, helping them understand the economic and environmental implications of their decisions.

The study aims to investigate how the IS business game can enhance students’ entrepreneurial skills, including negotiation abilities, holistic vision, and forward-thinking capabilities. This is crucial as entrepreneurial education must adapt to a changing economic landscape, encouraging future entrepreneurs to think sustainably. The paper addresses the need for educational models that prepare entrepreneurs to not only apply existing principles but also to pose new questions and find innovative solutions. Students complete a questionnaire right after the game to assess their knowledge and proficiency in IS and entrepreneurial thinking.

The business game is expected to significantly impact students’ understanding of IS and their entrepreneurial thinking skills. It’s anticipated that students will gain a deeper understanding of IS dynamics, develop sophisticated negotiation skills, and adopt a holistic view of entrepreneurial practices related to the circular economy. The study aims to highlight the transformative potential of experiential learning in shaping entrepreneurs equipped to navigate a sustainable business landscape. This research is a step towards understanding the role of innovative educational models in fostering a new generation of entrepreneurs who are prepared to tackle the challenges of a sustainable future.

Keywords: Circular economy; soft skills; sustainable management; entrepreneurship; education



Vermicomposting: An Idea to Work Science and Mathematics in Primary Education

Hugo Castanheira¹, Patrícia Morgado², Raquel Pereira³, Ana A. Cruz⁴, Ricardo Machado⁵

ISEC Lisboa – Instituto Superior de Educação e Ciências, Portugal ^{1,2,3,4,5}

Abstract

The Portuguese curricula point out the importance of interdisciplinarity when teaching in primary education, namely between Science and Mathematics [1]. In pre-service teaching, students should experience ways of promoting this kind of work. Inquiry Based Learning (IBL) is a pedagogical approach that engages students in new discoveries and allows the connections between these two sciences [2]. This investigation emerged from a joint work in two curricular units under Master's Degree in Preschool and Primary Education – Experimental Science Practices and Methodology for Teaching Mathematics. From a contemporary science issue proposed by students – what to do with the leftovers from home meals – they started an investigation towards a clean and environmentally friendly solution. The aim was to design and implement an IBL activity for 3rd grade; students themselves should also go through all IBL's stages. Mathematical knowledge should be used and integrated all along IBL work. We assumed an interpretative paradigm [3] and developed an action-research project [4]. The participants were the three students that developed this theme and the teachers from both curricular units, which acted as tutors along this work. Data were collected through documents' investigation, experimentations, observation, students' protocols and informal conversations. The procedures were developed in four phases: (1) the initial investigation performed by students allowed them to choose vermicomposting as the most suitable solution; (2) design of a proposal task to implement in the classroom, following IBL stages; (3) development of the proposal simulating what it is expected in a 3rd grade class; science and mathematical knowledge were used to collect, interpret and conclude about data obtained. In practical terms, a worm bin was built, species were selected and conditions for vermicomposting were studied; and (4) from the results and conclusions taken, a second investigation was performed (importance of compost for lettuce growth). During all the procedures, technical and scientific rigor was taken into account. The results shaped that these investigative activities promote scientific reasoning, critical sense, curiosity and introduce students to the scientific method, therefore, developing scientific and mathematical literacy. All the activities promote interdisciplinarity and stimulate student's participation, exploration, and development of abilities and competencies.

Keywords: Science Education, Mathematics Education, Interdisciplinarity, IBL

Using Visual Notetaking to Promote Participatory Equity in a Science and Math Methods Course

Michael R. Taber¹, Kristin Stanec²

Colorado College, United States^{1,2}

Abstract

This paper is part of a multi-year project on implementing visual notetaking strategies into undergraduate courses to promote equitable learning experiences, reflexive thinking, divergent thinking, and participatory equity. Here, we define participatory equity as the internalization of a sense of belonging, where teacher educators, learning science and math concepts, can engage with inquiry, intellectual challenge, and uncertainty in a space that utilizes various identity perspectives as assets, minimizing the “I am not good at math/science” mindset. Participants were undergraduate students in a science, technology, engineering, and math (STEM) teacher preparation methods course from six majors (courses of study), with 27% from a STEM discipline, 20% from humanities, and 53% from the social sciences. Visual notetaking exercises were used daily as part of the instructional process to assist students in connecting learning experiences to material reality as they learned about their STEM identities while learning STEM content and instructional design. Visual notetaking facilitated visual representation using visual thinking strategies, recognizing patterns, and defining structures through new notetaking forms. Learning experiences were designed to develop students’ conceptualizing of science and math while learning how to design learning for pre-adolescent students. By using visual notetaking strategies, students were able to practice divergent thinking (i.e., possibilities), convergent thinking (i.e., forms that express meaning), and risk-taking (i.e., the vulnerability associated with expression). Qualitative coding of open responses on a post-survey revealed two major themes: 1) Visual notetaking provided a mind space for learning about self, and 2) it provided a calming opportunity to connect concepts. Quantitative analysis indicated significant correlations between focused headspace and notetaking ($r = 0.555$, $p < 0.001$), focused headspace and connecting with others ($r = 0.405$, $p < 0.001$), and using imagination helps me learn and creating visuals helps me learn ($r = 0.528$, $p < 0.001$). In addition, students showed small gains ($\eta^2 = 0.03$) on a pre-post analysis on “a safe space for learning.” Future work now focuses on what students and professors perceive as possibilities for instruction and what students perceive as possibilities for more profound development of safe-space embodiment, intuition, tolerance, and the co-creation of knowledge.

Keywords: teaching methods, inclusion, equity, creativity, student engagement, STEM



Activating the Student's Prior Knowledge in the Learning of Third Newton Law through a P.O.E. ("Predict-Observe-Explain") Strategy

Juan Sabín

Santiago de Compostela University, Applied Didactics Department, Spain

Abstract

Laboratory experiments are commonly used in the teaching of experimental science. They have proven beneficial when they are designed to demonstrate concepts previously explained by the teacher. However, they often fail short when used to introduce the explanation of a new concepts. There is a necessity of designing new lab experiments that activate the student's prior knowledge in pursuit of more efficient learning when introducing new scientific concepts for the first time. The constructivist principles of learning are grounded in the notion that learning constitutes an internal reorganization process of the student's mental frameworks, which undergo more significant modifications when learners encounter discrepancies with their prior ideas. Hence, many constructivists learning strategies place emphasis on leveraging students' prior knowledge as a fundamental starting point. A method to translate this approach into the teaching of science involves the utilization of P.O.E. strategies (Predict, Observe, Explain). In this work, we present several P.O.E. experiences employing counterintuitive experiments based on third Newton's Law. These experiments were specifically designed to challenge students' predictions and uncover common misconceptions in comprehension of the Newtonian mechanics. Specifically, scenarios such as the behavior of an analog scale when a person raises on tiptoes; and the movement of a ship propelled by its own fan often contradict many student predictions, including those of prospective secondary school educators. These experiences also highlight the importance of the capacity of students for scientific abstraction and the correct use of rational argumentation to correctly explain the counterintuitive experiments and to argue against their own previous predictions. The P.O.E. experiences were tested with prospective secondary school educators to assess the level of significative learning facilitated by this constructivist approach.

Keywords: Constructivist, Predict-Observe-Explain, P.O.E., Newton's Law, Prior-Knowledge.



Educational Tourism in Bulgaria: New Research Project

Sonya Spasova¹, Svetoslava Dimitrova²

University of Library Studies and Information Technologies, Bulgaria^{1,2}

Abstract

The intersection points in the interaction of three state management systems, namely: cultural heritage, education, tourism in Bulgaria, has so far not been the subject of a complex study. Each of these systems is managed by state institutions that have a high degree of overlapping funding and responsibilities. This paper presents a new research project entitled “Research of opportunities for the implementation and development of educational tourism in Bulgaria: Cultural heritage in support of formal education”, that in 2023 won the Competition for financial support of basic research projects, organized by the Bulgarian National Science Fund, part of the Ministry of Education and Science of the Republic of Bulgaria, Contract № KP-06-N75/17 from 15.12.2023, led by Chief Assist. Sonya Spasova, PhD. The goals and results of the project are presented. The set goals of the project proposal include, in addition to the study of international good practices and the analysis of published scientific studies on the subject, conducting field studies (surveys, interviews, photo-documentation of selected objects that directly correspond to school education and the development of tourism in Bulgaria), also publishing a monograph and a teaching aid. The object of research is educational tourism in Bulgaria. The subject of research are pre-selected sites of national cultural heritage as a potential for the development of educational tourism in the country, with the aim of increasing the effectiveness and efficiency of formal education in Bulgaria. It is envisaged that the selection of objects will be categorized into three historical eras: Antiquity, Middle Ages, Bulgarian Revival. The methods and approaches envisaged include: a survey of published literature on the subject; conducting field studies (surveys, interviews, photo, and video documentation), analyses and synthesis of regulatory documents.

Keywords: Research project, Cultural Tourism, Cultural Heritage, Education

Is There a Place for Regular Mid-Semester Assessments in Higher Education?

Zsófia Frányó¹, Péter Tasi², Boglárka Szijártó³, Barbara Kardos⁴

Budapest Business University, Hungary^{1,3,4}
Aston University, Birmingham United Kingdom²

Abstract

By the 21st century, higher education has evolved into an essential component of the global economy, influenced by economic forces and societal expectations [1]. The increasing student population, coupled with growing diversity, necessitates ongoing innovation as traditional knowledge transfer methods prove inadequate [2][3]. Core challenges include enhancing quality and minimizing attrition [7], demanding continual adaptation to diverse student needs and objectives [19]. Innovative thinking becomes imperative in this context [20]. This empirical study investigates the effectiveness and student acceptance of a novel assessment system implemented in the accounting department of a prominent Central European university of economics. The system allocates 30% of scores through diligence-based regular tests and 70% through end-of-semester exams. Utilizing qualitative research methods, including questionnaire data collection in correspondence courses, the study targets students engaged in online video course materials within the 1st semester of 2023/2024, amassing responses from over 220 participants. Results indicate a favourable shift in student effectiveness (grades and dropout rates) under the new system, with clear student endorsement. Feedback highlights that the test schedule enhances curriculum adherence, offers practice opportunities, facilitates continuous progress, and serves as an exam model, providing ongoing feedback on knowledge levels. This formative assessment approach supplements summative evaluations, contributing to students' developmental growth. Conclusively, the findings endorse the utility of the new assessment system, recommending its continued use with potential for minor adjustments, such as percentage modifications and test reopening for practice purposes. Despite limitations tied to a specific scientific field and institutional context, positive outcomes prompt further educational development and research.

Keywords: formative assessment, student satisfaction, dropout, part-time training, regular assessment



The Potential of Virtual Reality for Teaching and Learning Purposes

Anna Bekeeva¹, Elena Notina², Irina Bykova³

RUDN University (People's Friendship University of Russia), Russia^{1,2,3}

Abstract

Many spheres of activity are undergoing changes due to the active development of information computer technologies, which contributes to the modification of various fields of knowledge, education and science. The purpose of this study is to explore the potential of virtual reality technologies in learning as an important part of the modern educational process. VR in education is aimed not at replacing the teacher, laboratory and practical classes, but at motivating the student and teaching him in a new way. The research proves that one of the main advantages of using VR in teaching foreign languages is the creation of an authentic language environment. Students can immerse themselves in virtual scenarios where they can interact with native speakers, hear real conversations, and participate in simulated communication situations. It helps students develop communication skills in a foreign language in a realistic environment. VR in education can enhance collaborative learning. Learners can interact with their peers and the virtual environment, making the experience more active. It can additionally offer students a personalized learning experience by allowing them to explore the virtual world at their own pace and in the way. Students can improve their comprehension of the subject matter by using VR technology to deliver personalized feedback. VR has a notable benefit in education as it offers a cost-effective solution. Instead of arranging physical models or field trips, educational institutions can generate a virtual environment that can be accessed by many students simultaneously. The analysis revealed that the use of VR in education has the capability to revolutionize the learning experience for students through immersive and captivating engagement that can enhance their comprehension of the subject. Providing an interactive VR experience has the potential to connect theoretical concepts with practical applications, thereby equipping students with the confidence to face future challenges.

Keywords: digitalization, education, virtual reality, digital technologies, virtual environment

Engineering Education



Exploring Changes in Students' Understanding the Basic Concepts of Data Analysis in Introductory Laboratory Course “Search for Physics Laws”

Oksana Lozovenko¹, Dominik Giel²

Offenburg University of Applied Sciences, Germany^{1,2}
National University “Zaporizhzhia Polytechnic”, Ukraine¹

Abstract

Laboratory courses have always been one of the most important components of university science courses. It is expected that first-year engineering students will acquire basic skills to deal with experimental data after such course. This ability to generate knowledge using experiments they could and should use later in subsequent courses. However, a number of pedagogical researches revealed that most students do not master the necessary skills. As one possible way to solve this problem, the course “Search for Physics Laws” was developed. This course is based on the theory of the gradual formation of mental actions and can be put into educational practice by using different laboratory equipment. Evaluation of the course showed that the organized in the new way laboratory sessions is more effective than traditional laboratory sessions. In this work, we consider in detail how students' understanding of the basic concepts of error analysis changes over the course.

Keywords: *systematic construction of mental actions, laboratory course, analysis of experimental data, physics law*



Open Source Gamified Remote Labs in Photonics Education

Johannes Kretzschmar¹, Clara Henkel², Christian Helgert³, Thomas Pertsch⁴

IAP, Friedrich Schiller University Jena, Germany^{1,4}

ASP, Friedrich Schiller University Jena, Germany^{2,3}

Abstract

Remote Labs are nowadays a widely used educational resource in curriculums of a wide range of scientific fields. The growing technological advances and progressing digitalization of education provides an ecosystem of possibilities to experiment with new means of communicating science. In this paper, we will present an approach to combine remote laboratories with gamification and storytelling all in one.

Although, the development and implementation are usually associated with costs and resources, we provide a framework solely based on open technology. From 3d-printing and off-the-shelf components on the hardware side to free software libraries and technology for implementing web applications and endpoints for augmented (AR) and virtual reality (VR) – open source enables reducing costs while developing platform and device independent applications.

Based on this technological implementation, we also developed a best practice for embedding learning content in an attractive and state-of-the-art manner directly within the 3D visualization of the experiment. Our method particularly relies on sequential storytelling for historical and research narratives, as well as gamification for an abstract, interactive visualization of the experiment itself.

With the integrated educational content, remote experiment applications offer a comprehensive, holistic learning experience for self-paced learning.

Keywords: Remote Lab, Open Source, Gamification, Photonics



Novel Approach for Teaching AI in Entry Level Education

Samuel Kübler¹, Christian Bildhauer-Buggle², Thomas Schiepp³

Furtwangen Hochschule University, Faculty of Medical and Mechanical Engineering,
Campus Schwenningen, Jakob-Kienzle-Straße 17, 78054 VS-Schwenningen,
Germany^{1,2,3}

Abstract

The proliferating fielding of artificial intelligence in various but especially industrial applications increases the need for pupils, students and employees in STEM areas and leads to a new job profile, the AI engineer, who does not necessarily require a full study in computer sciences. Extensive efforts are undergone to improve education at the K-12 level, but even at the university level educators are struggling to keep pace with the development of AI. At the same time, a continuous stream of presentations in digital media reveal an unbroken fascination with industrial robots, even though their emergence dates back decades. Our approach to stimulate students' interest in AI education leverages the appeal of physical interaction with an AI via a 6-DOF robot rather than an auditory or purely visual interface. In order to keep access to robot programming as a hurdle as low as possible, we expand the graphic programming ability of an industrial robot user interface with a self-designed game-card concept and combine this with an AI hard- and software that is either pre-trained or trained as part of a problem-solving exercise. We present a step-by-step approach for artificial intelligence in education (AIED) that is characterized by increasing complexity of the exercises and can therefore be adapted to offer different levels of interactive learning environments (ILE). Part of this step-by-step approach is also the presentation of the development of information processing from strictly linear (the robot control) via object-oriented (in the interaction of the AI with the robot) to the AI itself in an overall project that combines all stages and concepts. This interactive learning environment thus enables an adjustment in both the level of difficulty and - by selecting the sub-areas - the amount of time in teaching the application of AI in a real-world scenario.

Keywords: Science, Technology, Engineering and Mathematics (STEM), Artificial intelligence in education (AIED), Interactive learning environments (ILE)



Smart Building Engineering: Challenges and Opportunities of an Interdisciplinary Course Concept for Engineers in the Field of Technical Building Equipment

Lina Schulze-Buxloh¹, Rolf Groß²

FH Aachen University of Applied Sciences, Germany^{1,2}

Abstract

The share and sales of technical building equipment in construction projects is constantly growing [1], so that engineers for technical building equipment are increasingly needed for demanding construction and renovation projects. The classic engineering courses such as for example, civil engineering, supply technology or electrical engineering often only cover their respective sub-areas, although specialists are needed for these interface areas, especially for planning and design of technical building equipment. The bachelor's degree program "Smart Building Engineering" is successfully implemented in an interdisciplinary manner by the three departments of civil engineering, architecture and electrical engineering and information technology. Both in the organization and in the development of the curriculum, new challenges and opportunities arise for innovative training of specialized young engineers for technical building equipment. In particular, the different work and approaches of the trades involved in the construction process require a high level of interdisciplinary communication and knowledge of the different perspectives later in the job in order to realize a successful construction process. The methodology of Building Information Modeling (BIM) is also taught and directly applied during the course for getting the students used to this collaborative way of thinking.

Keywords: Smart Building Engineering, BIM, interdisciplinary curriculum development

Enhancing Student Engagement



Situational Interest in Geology Learning: What Learning Strategies Promote Student Interest in Geological Topics?

Jitka Kopecká

Palacký University, Faculty of Education, Department of Biology, Czech Republic

Abstract

This study examines the various factors that may influence students' interest in studying geology. It is based on the experience that the geology learning content is often perceived by students and teachers as complex and difficult for students to understand. The research involved 9th-grade students in randomly selected elementary schools completing various tasks focused on geological observation, modelling, and timing in geology. They worked in groups on all tasks and had the opportunity to discuss the problem among themselves and with the teachers. The research investigation aimed to find out how significantly a particular teaching situation can influence the formation and development of students' interest in a learning topic and, consequently, in learning subject. We looked at the role of situational interest development, which can be triggered by a range of factors from appropriately chosen teaching strategies to the personality of the teacher. The results showed that high student interest was stimulated by methods that led to their direct involvement in the learning process. Methods based on modelling and observation of geological objects and phenomena were the most appreciated, while methods based on inductive deductive procedures with a higher degree of abstraction and numerical operations were slightly less appreciated. The instructional strategies that most engaged students also demonstrated a higher interest in the learning topics conveyed by these strategies. Thus, the research investigation highlighted the importance of deliberately shaping the learning environment in favour of developing situational interest to further stimulate deeper student interest in specific learning content.

Keywords: *interest in geology, situational interest, students' activation, learning topics, learning strategies, learning environments*

Extra Curricula Activities

**Let's Go Out!**

Popular Outdoor Education - Limiting Factors Versus Positives

Dagmar Vašutová¹, Irena Vrbová²

Department of Biology, Faculty of Education, Palacký University in Olomouc
Czech Republic^{1,2}

Abstract

Outdoor education (OE) has been seen as a powerful teaching strategy in recent years, especially in science education. Numerous types of methods and forms of teaching can be used, and several authors have reviewed their descriptions. Hence, the authors of this article decided to analyse the situation with outdoor science education in Czech schools, where it is not yet mapped in detail. The research was performed by using a questionnaire study, to which several teachers from elementary schools in all regions of the Czech Republic responded. Two hundred and sixty-one questionnaires were received in an online form (by Survio platform) and then they were processed. The authors focused on four main points - namely the location of the school (rural versus urban) and the effect of school location on the frequency of OE. Next, on the barriers and positives of OE. The regular frequency of OE at the shortest evaluated intervals (once a week) was up to 10 times higher in village schools (it was also statistically confirmed by the Chi-square test). The Likert scale was used to discuss the limiting factors of OE. Teachers most often marked the weather as the very inhibiting element (169 respondents). On the other hand, the risk of accident or injury during lessons was cited as the least limiting (16 respondents). The respondents mentioned twenty-eight positive effects of OE. The authors classified these 28 points into three areas: improved learning methods, health benefits, and improved pupils' education. Our respondents chose that the biggest benefit of OE is being in the fresh air (56 % of respondents). The second classification was based on different types of teaching and learning strategies. The authors identified three main types of learning / teaching activities: 1) place-based education, 2) experience-based learning, and 3) real-world learning. From the results, and not only from our research, it is also evident that OE is a form of teaching and learning that has many positive aspects and, although it has its limits, it should be fully powered in schools for all age pupils' categories.

Keywords: science education, outdoor education, frequency of outdoor education, positives, and limits of outdoor education

Regarding Collaborative Efforts among Universities, High Schools and Boards of Education to Develop Scientific Skills

Mika Tsuyukubo¹, Masayuki Takahashi², Mariko Haraguchi³
Naoko Yamada⁴, Takuya Mochida⁵

Toyo University, Japan¹

Saitama Prefectural board of education, Japan^{2,3}

Saitama Prefectural Ina Gakuen Comprehensive Upper Secondary School, Japan⁴

Saitama Prefectural Sugito Agricultural High School, Japan⁵

Abstract

In order to increase high school students' interest in science and deepen their understanding, it is thought that not only regular classes but also organizational efforts in collaboration with universities and boards of education are effective. Therefore, universities, high schools, and the Board of Education have collaborated to hold a course that aims to explore the appeal of science beyond regular classes, and I would like to report on this initiative. The target schools were two schools in Saitama Prefecture, and the study was conducted for half a day. Participants were informed and recruited from the Saitama Prefectural Board of Education and the participating schools, and the content was related to cooking science, which is the specialized field of university instructors, and included instrumental measurement and measurement of the various physicochemical changes that occur during cooking. The analysis included sensory evaluation. For example, in a course on puffed cooking, we used cupcakes as the subject matter and conducted experiments to clarify the effects of different amounts of added sugar on the finished product. We started the experiment by first thinking about what kind of differences would emerge, and encouraging participants to take an observational perspective during the experiment. Objective comparative verification was carried out by observing the air bubbles in the dough using a microscope, measuring the hardness of the baked dough using a hardness meter, and measuring the color of the dough using a colorimeter. After the experiment, they explained the mechanism behind the effect of sugar on differences in leavening properties, and shared knowledge about the denaturation of egg proteins, thermal expansion of air bubbles, and the Maillard reaction. The high school students who participated were very interested in the course, which had a different structure from their regular classes, and had a high level of satisfaction after taking the course. It has been suggested that the course, which was realized through collaboration between universities, high schools, and boards of education, is effective as a system that allows students to approach science beyond the framework of academic subjects while still being based on the high school curriculum.

Keywords: Collaboration, high school, cooking science

Preschool and Primary Education



The Level of Scientific Literacy Among Primary School Pupils: Preliminary Results

Petr Kovarik¹, Romana Adamkova², Milan Kubiátko³

J.E. Purkyne University, Faculty of Education, Department of Preschool and Primary Education, Czech Republic^{1,2,3}

Abstract

Scientific literacy is a term which is often mentioned in the context of contemporary problems and in the current society in general. Scientific literacy is a term used since the 1950s to describe the scientific knowledge of broad public; although almost 75 years have passed, its definition is still not unanimous; the term lacks a single universal definition. The main aim of the research was to determine the level of scientific literacy among primary school pupils and also to determine differences in the level of scientific literacy with regard to the relevant grade and gender. The total of 112 pupils from 3 primary schools selected from the schools available participated in the research. The research tool was designed from published TIMSS 2019 tasks aimed at the scientific literacy with 4-grade pupils. The test tool consisted of 12 questions diversified according to their difficulty to 2 – 5, similarly as in the TIMSS test. I used 3 tasks in every category of difficulty. In order to fulfil the research aims, the inductive statistical methods were used, specifically the student's t-test for independent selections. If we focus on the results of the scientific literacy test from the age perspective (or the relevant grade), we concluded that 9-grade pupils achieved statistically much better results in all test areas and there were no statistically significant differences in the success rates of boys and girls.

Keywords: primary school pupils; quantitative approach; scientific literacy; test



Heritage and Computational Thinking: Intersections for Meaningful Learning in Primary School

Cristina Maia¹, Paula Quadros-Flores², Dárida Fernandes², António Flores³

School of Education of the Polytechnic Institute of Porto, Portugal; CITCEM – Research Centre Transdisciplinary "Culture, Space and Memory" - FLUP; InED - Centre for Research and Innovation in Education¹
School of Education of the Polytechnic Institute of Porto, Portugal; InED - Centre for Research and Innovation in Education²
Superior Institute of Engineering of Porto, Portugal, Polytechnic Institute of Porto³

Abstract

As the school is a place of culture, oral and material heritage can play an important role in a close connection with the historical past and linguistic development. Integrating this work into a disciplinary articulation with computational thinking can be an initiative that promotes meaningful learning and stimulates the development of cognitive and creative problem-solving skills. Based on the current curricular guidelines of the Profile of Students Leaving Compulsory Schooling [1] and the Core Learning Frameworks for Environmental Studies [2] and Maths [3], we sought to investigate how the different components of computational thinking promote the construction of historical and cultural knowledge experienced by children in the classroom. To this end, lesson plans were drawn up in which the articulation of knowledge was the fundamental axis of the learning experiences outlined, with the child constructing their own learning through observation, critical analysis and problem-solving, mobilising knowledge to make decisions and thus build more solid learning.

From a qualitative perspective, this research was carried out in the context of initial teacher training for Professional Master's programmes, based on the trilogy of planning, intervention and after-action reflection, and on an interpretative process that allowed us to consider categories of analysis highlighted in the discussion of results. The following categories will be presented in this article: connecting computational thinking with history and culture, connecting computational thinking with the present and the future, stimulating problem-solving skills with the use of a robot.

The results show that connecting computational thinking with oral and material heritage fosters a reality-simulating environment that makes learning meaningful and gives meaning to curricular content. It also favours interdisciplinary learning in a problem-solving environment in which students understand the past and present of the context in which they live, building knowledge, attitudes and values for life.

Keywords: cultural heritage; computational thinking; interdisciplinarity; initial teacher training



The Teachers' Action for Health – Teachers' First Aid Intervention in Emergency Cases at School

Irina Gheorghiu¹, Loredana Danaila², Alexandra Hanu³,
Claudia Dinu⁴, Ovidiu Ursa⁵, Stefan Colibaba⁶

Albert Ludwigs Freiburg University, Germany¹

EuroEd School Iasi, Romania^{2,3}

University of Medicine and Pharmacy, Iasi, Romania⁴

University of Medicine and Pharmacy Cluj-Napoca, Romania⁵

Al. I. Cuza University Iasi, Romania⁶

Abstract

The article is based on the TA4H project - funded by the European Commission under the Erasmus+ KA220-SCH - Cooperation partnerships in school Education. The project is being implemented by the EuroED kindergarten and primary school, Iasi, Romania, within a partnership of schools, NGOs, universities, and health institutions from Turkey (coordinator), Bulgaria, Greece, Latvia, Lithuania and Romania. The main goal of the project is to support teachers in primary and preschool education to improve their knowledge and increase awareness of situations in which students may need first aid intervention or emergency response in case of chronic diseases, through the use of digital educational materials. Furthermore, the project aims to ensure the continuity of this knowledge and skills. Understanding the importance of first aid and chronic disease management in schools is crucial to ensure the safety, well-being, and academic success of children. The project stems from a rigorous needs analysis carried out in all partner countries to identify the top priority issues in the field of first aid that teachers face and the current state of preparedness, the availability of resources, and the effectiveness of training programs. The project's goal is to develop training programmes for pre-primary and primary teachers that address the specific needs and challenges identified. The article looks into the findings of the needs analysis in Romania and provides some insights into the project's objectives, target users, and main deliverables.

Keywords: kindergarten and primary school, first aid intervention, emergency, teachers



How Much Students in Primary School Know about Waste Sorting? (Pilot Research)

Igor Dobrača

Primary school Juraj Dobrila Rovinj, Croatia

Abstract

The Croatian education system incorporates sustainable development as one of its seven cross-curricular topics. The cross-curricular theme mentioned above encompasses the three dimensions of sustainable development, namely environmental (reduce and reuse), social (respect, rethink and reflect), and economic (recycle and redistribute) and can be connected to the European competence framework for sustainability GreenComp. The objective of the pilot study was to assess the knowledge level of 60 students of 6th grade primary school. This assessment was conducted after they had completed the waste management activities covered in the second educational cycle, which typically takes place in the 3rd, 4th, and 5th grades of elementary school. The analysis was conducted utilising Jamovi software, and based on the findings of the pilot study, it was ascertained that a majority of the students lack proficiency in waste sorting, hence highlighting the need for additional education in this domain. The majority of responders provided accurate responses regarding the weight of bio-waste. It can be inferred that the assessment of educational objectives, even though brief evaluations, is vital for enhancing knowledge adoption.

Keywords: primary school, sustainable development, waste sorting

Science and Environment



Accessible and Enriched Community-Engaged Learning: A Botanical Virtual Classroom Field Trip

Poh Tan¹, David Zandvliet²

Simon Fraser University, Canada¹

Simon Fraser University, Institute for Environmental Learning, Canada²

Abstract

The Bloedel Conservatory, located on the unceded traditional territories of the xʷməθkʷəy̓əm (Musqueam), Skwxwú7mesh (Squamish), and səliłwətał (Tsleil-Waututh) Nations in Vancouver, Canada, serves as an educational resource for the province's schools. The peak of the COVID-19 pandemic posed challenges for schools, teachers, and educators to access the Conservatory. In response, a collaborative effort with the educational group at the conservatory led to the creation of a curricular-aligned virtual classroom field-trip online teaching resource. This community-connected learning initiative features pre-recorded storytelling and semi-immersive videos showcasing the Conservatory's unique plant species, accompanied by curriculum-aligned lesson plans. Using the ArcGIS Story Map platform, the project maps the global origins of plants, integrating video, audio, and 360-degree content for an engaging virtual experience accessible through Wi-Fi-enabled devices. The project aims to achieve three objectives: 1) overcoming accessibility challenges for province-wide student and teacher access, 2) fostering deeper connections between individuals and plants (especially non-native species), and 3) engaging in community-based research and collaboration to promote scientific and environmental literacy. The experiences include a general virtual tour, an activity booklet, a virtual hibiscus-focused encounter and banana-themed exploration, and a blended/hybrid virtual learning lesson. These experiences weave together science, storytelling, singing, and dancing, contributing to an appreciation of biocultural diversity. Coined by Luisa Maffi, biocultural diversity recognizes the interconnectedness of biodiversity and cultural diversity, emphasizing the integral relationship between nature and culture. This approach underscores the significance of understanding and preserving the multifaceted tapestry of life on Earth, encompassing biological, cultural, linguistic, and ecological dimensions. By transcending geographical boundaries, the project invites exploration and learning about the rich biodiversity within the Conservatory's dome, fostering a deeper understanding of the intricate relationship between biology, culture, and language.

Keywords: *biocultural diversity, science education, scientific literacy, environmental literacy, virtual classroom, Indigenous science.*



Creating Field Experiences to Promote Scientific Learning

Melissa Caspary¹, Diane Boothe²

Georgia Gwinnett College, United States¹

Boise State University, United States²

Abstract

Scientific learning in our complex world is undergoing rapid transformation. Field experiences to promote scientific learning are at the forefront of best practices as science educators strive to inspire students with hands-on active learning strategies that foster innovation, creativity, and revitalize the educational experience. Field experiences in the sciences also promote the development of place-based understanding. Students who engage in field experiences have greater opportunity to cultivate critical connections to real places that transform abstract concepts into tangible realities [1]. Students engaged in the field of biology were positively impacted by field experience. Through their work in the field, the students were able to enact science autonomously; they engaged with peers and teachers in specific ways and developed new understandings about research and epistemology founded on their experiences in the field [2]. The goals of this presentation and paper are to share knowledge of creative field experiences relating to the biological sciences. The multidimensional aspects of field experiences as essential components to scientific learning are comprehensive and provide strong links and valuable information that contribute to expert teaching and learning. Emphasis is placed on the creation of field experiences that will challenge students and encourage them to excel as they tackle complex curriculum topics. The presenters will provide resources to support students and educators as they share knowledge, best practices, and strategies for success in field experience design.

Keywords: *Field experience, Scientific learning*

CO₂ Monitoring to Enhance Digital and Green Competences in VET

**Mariaconcetta Canino¹, Enrico Cozzani², Francesco Marucci², Gabriela Carrara³,
Stefania Marzocchi³, Stefano Zampolli¹, Francesco Suriano²**

CNR-IMM, Via P. Gobetti 101, 40129 Bologna, Italy¹

Proambiente Scrl. Via P. Gobetti 101, 40129 Bologna, Italy²

“Dario Nobili” CNR Library, Area della Ricerca di Bologna, Via P. Gobetti 101, 40129 Bologna, Italy³

Abstract

This contribution presents the results obtained within the KA2 Erasmus Plus project CO₂ Monitoring in Schools for digital and green competences (CHANGE) [1]. The consortium, made up of an Italian Research Institute and four VET schools in Bulgaria, Italy, Romania and Spain, is developing, testing and optimizing a didactic pathway centered on Indoor Air Quality [2] in schools. The pathway combines digital skills, i.e. system integration, programming and data processing, with socially relevant topics such as IAQ monitoring, energy efficiency, greenhouse gases and climate change, raw materials and open data, in order to provide students with competences useful to meet the requirements of the labour market and to foster their critical thinking on scientific basis. The experimental section consists in the assembly of CO₂ monitoring stations controlled by a Raspberry PI microcomputer with open-source code programmed in Python, and in its use for the continuous monitoring of the CO₂ concentration in the classroom. The acquired data, as well as the metadata needed for their interpretation, are collected in an open data repository [3] based on CKAN [4]. Mid-term monitoring (approx. 1 month) has been carried out in different indoor spaces and the results, analyzed by the students themselves, will be presented. The outcomes of the first project year (2022-23), testified by questionnaires and CO₂ monitoring reports, show a general satisfaction towards the pathway and the Erasmus Plus dissemination activities. As a drawback, the metadata annotation, needed to obtain reliable and reusable monitoring data, shows some weaknesses. The mitigation solutions that are going to be tested within the second year (2023-24) of the project include teachers' training on open data management, software interface simplification, and increase of the detail in the annotation and reporting guidelines provided to the students. This presentation will eventually discuss their effectiveness and ease of implementation. Indeed, the ultimate goal is the establishment of a reliable action chain connecting monitoring with open data in order to enhance further elaboration and citizen science initiatives involving schools.

Keywords: indoor air quality, digital, sensors, open source, data, citizen science



Sustainable and Healthy Nutrition – How Do Young People Eat?

Julia Holzer¹, Doris Elster²

Institute for Science Education - Biology Education, University of Bremen, Bremen, Germany^{1,2}

Abstract

The production, processing and consumption of our food play a decisive role in the consideration of human resource consumption. Against the current climate change, increasing land consumption, decreasing water availability and a growing world population, the review and adaptation of food systems in terms of social, ecological and economic sustainability is one of the central tasks both for politics and for the agricultural and food industry. Our nutritional habits are an important field of action for promoting ecologically sustainable development. However, it is not always easy for individuals to make the right decision in terms of a healthy and sustainable nutrition. Our eating behavior is highly complex and linked to other everyday activities in many ways. The following study attempts to uncover the extent to which young people eat sustainably and healthily. This question is considered in terms of the theory of planned behavior. The intention of young people to eat healthily and sustainably is considered, as well as other motivational factors such as attitude (ATT), subjective norm (SN) and perceived behavioral control (PBC). In addition, the level of knowledge on the topic and its influence on the intention is measured. A total of 171 students (age $\bar{x}$: 17.3; n= 96 ♀/ n =75 ♂) from Bremen completed a questionnaire. The results clearly show that especially ATT and PBC toward sustainable and healthy nutrition correlate positively and significantly with intention. There is also a significant and positive correlation between knowledge (amount of information, system-knowledge and action-related-knowledge) and intention to eat healthily and sustainably. The results of the regression analysis also show that the theory-internal factors (ATT, SN and PBC) together explain 53% of the intention to eat healthily and sustainably. If knowledge is also taken into account in the model (self-evaluation of knowledge), the model explains a further 2% of the intention. In the extended model, ATT, PBC and knowledge are the key determinants of intention. It is clear from these results that these influencing factors should form the starting points in subsequent studies in order to sensitize students to healthy and sustainable eating habits.

Keywords: *Theory of planned behavior, attitudes, knowledge, sustainable and healthy nutrition*



The Crystal Lake's Mystery: Interactive Eco-Crime Game for Learning about Environmental Sustainability

Denise Galante¹, Michela Tassistro², Armida Torreggiani³

CNR-SCITEC, Institute of Chemical Sciences and Technologies “Giulio Natta”,
National Research Council, Italy^{1,2}

CNR-ISOF, Institute for Organic Synthesis and Photoreactivity, National Research
Council, Italy³

Abstract

Implementing measures to mitigate the impacts of climate change and its consequences is crucial. Safeguarding, restoring, and promoting the sustainable management of terrestrial ecosystems are essential to combat the decline in biodiversity. This comprehensive action plan aims to enhance the well-being of people, protect the environment, and foster global prosperity. These critical themes can be thoroughly examined within the framework of “The Crystal Lake’s Mystery”, an educational eco-crime game, set up for high schools’ students. This educational game is a useful tool for making youngsters aware of the complexity and interrelation of science with environmental sustainability issues and with the benefits of the scientific method and multi-disciplinary knowledge.

In fact, “The Crystal Lake’s Mystery” incorporates a blend of STEM subjects, emphasizing chemistry and biology, to navigate the investigation so it acts as interdisciplinary educational tool. Participants are organized into teams and tasked with probing four companies near the lake, aiming to uncover the cause, culprit, and process behind the fish mortality that suddenly occurred in the lake. By using a “detective board,” teams strategize and evaluate evidence obtained by chemical and biological laboratorial analyses.

This interdisciplinary activity offers a rich learning experience to the participants, merging scientific concepts from chemistry, biology, and environmental subjects, aiming to enlighten students about sustainability, environmental conservation, and responsible resource utilization, fostering a generation committed to a sustainable future. In addition, the playful approach supports students’ engagement, motivation, and the creation of a conducive learning environment.

The session culminates in a quiz, determining the successful detective team, encouraging active participation, critical thinking, and problem-solving abilities. This initiative may be a valuable educational tool, capable to promote sustainability and environmental awareness in high schools.

Keywords: Serious game, chemistry, biology, environmental protection, cross-curricular learning.

Science and Society



Librarians in Bulgaria and the Trends in the Information Environment

Elena Popova¹, Tania Todorova²

University of Library Studies and Information Technologies, Bulgaria^{1,2}

Abstract

The paper presents the results of the survey, titled 'Library professionals in Bulgaria and the changing information ecosystem', implemented among Bulgarian librarians in March 2022. The survey aims to examine the level of awareness about the Sustainable Development Goals (SDGs) and the changing global information environment among professionals working in Bulgarian libraries. The research methodology includes the implementation of an empirical online survey and analyses of the dataset of answers of 200 respondents (equivalent to above 10% of all the employees working in the Bulgarian libraries according to the Bulgarian Statistics Institute and its data out of 2022) using standard statistical methods and online desk research. The goal of the paper is to show the findings and to analyze them in the context of the LIS research and practical field.

Keywords: Librarians, Bulgaria, Sustainable Development Goals, IFLA Trend Report



Misconceptions about Current Biotechnology in Society: What to Focus On in School and Lifelong Education?

Michaela Horniaková

Department of Biology, Faculty of Education, Palacký University Olomouc, Czech Republic

Abstract

The progress of biotechnology is unstoppable and its impact on society is unquestionable. Consequently, it is imperative to grasp the prevailing awareness not only among students but also in the larger societal framework. The study used interviews as the primary research method, employing a semi-structured format for flexibility beyond pre-defined questions. A total of 40 respondents participated in the research, and the collected data underwent both qualitative and quantitative analyses. For qualitative analysis, the Grounded Theory [1] was applied, categorizing coded segments from transcribed interviews into four key concepts: biotechnology, genetic engineering, genetically modified organisms (GMOs), and cloning. Across these concepts, many respondents expressed a negative connotation. Misconceptions were diverse with the prevalent idea being that biotechnology and genetic engineering produce or are akin to robots or machines, unrelated to living organisms. Additionally, respondents associated biotechnology, genetic engineering, and GMOs with breeding. Quantitative analyses revealed notable gaps in awareness. Almost 30 % of respondents had limited awareness of biotechnology, and nearly 33 % lacked information on genetic engineering. Regarding GMOs and cloning, respondents were unaware of their nature. The misconceptions that emerged from the research may help in the future to identify critical areas that need to be addressed in raising awareness of biotechnology in society. This is vital for both academic settings and lifelong education.

Keywords: biology instruction, education, biotechnology awareness, lifelong learning



“Expli’CIT”: A New Serious Game to Strengthen Science-Society Dialogue Making Explicit Research Processes

Juliette Anglade¹, Pierre-Luc Marchal², Jonas Durand³, Annick Brun-Jacob⁴,
Pascale Frey-Klett⁵

Université de Lorraine, INRAE, IAM, F-54000 Nancy, France^{1,2,3,4,5}

Abstract

The international movement for Open science promotes accessibility, inclusivity and transparency to help solve complex socio-economic and environmental challenges. An important perspective of this movement, is to provide access to the practices and tools of the research cycle. We present here a serious game designed by “Tous Chercheurs” to better understand science-in-the-making and facilitate dialogue of knowledge. The aim is to explore the pathways that lead to the production of new scientific knowledge. It makes visible the structuring elements of scientific activity (reasoning, practices, professions, values, ethics, temporalities ...). Players, supervised by a scientific tutor, use word cards magnets to create a fresco by sharing different representations of research and agreeing on a common language. This collaborative tool, named Expli’CIT, can be used with citizens and in all training courses from secondary school to doctorate. It was step-by-step designed through participant observation between 2020 and 2023 during 40 game sessions. We observed that the game greatly facilitated the dialogue between academics and non-research actors in a variety of intermediation situations. The participants better understood the answers that science is able to provide or not, and sharpened critical thinking skills. In higher trainings settings, the game has proved effective in promoting interdisciplinarity dialogue and reflexivity thanks to insights into the philosophy of science. Expli’Cit offers new perspectives both in formal science education and in the development of participatory science and research because it provides a solid basis to jointly explore problems with scientific rigor and integrity.

Keywords: Critical thinking, serious game, interdisciplinarity, citizen science, research education, Tous Chercheurs



The Post-Pandemic Takeaways on STEM Literacy

Nikolaos Fotou¹, Marina Constantinou²

University of Lincoln, College of Arts, Social Sciences and Humanities, United Kingdom¹
Independent Researcher²

Abstract

The COVID-19 pandemic transformed the world at an unprecedented pace and still, to a lesser extent, is changing people's behaviours, decision making and lifestyle choices. Coping with the challenges of this transforming world and understanding the changes in people's daily lives has raised -or so it is widely argued- public awareness of the importance of STEM education and the impact that scientific literacy has on personal decision-making and action. This has brought on the 'STEM education for all' in the foreground in that there is a need for a STEM literate public to function and respond to the unprecedented amounts of scientific, mathematical (mostly statistical) and technical information exposed to during and post-pandemic. 'STEM education for all' can be thus defined as someone having "... the ability to engage with science related issues, and with the ideas of science, as a reflective citizen" [1, p. 22] which in the pandemic/post-pandemic era would imply a critical consumption of COVID-19 information and scientifically informed decisions by the non-scientist individual. Indeed, an understanding of, and engagement with, science can undeniably affect both public and personal decisions. However, a question that reasonably arises is how realistic it is for the average individual to have both breadth and depth of knowledge to a sufficient level to collect and analyse evidence and validate claims to then form rational and scientifically informed opinions on the science behind the COVID-19 or other contemporary issues like climate crisis [2]. This opinion-based paper draws on previous work [3] that questions the feasibility of 'STEM education for all' that would enable the non-scientist individual to make rational and evidence-based decisions about a broad range of socio-scientific issues. It is argued that this is both unrealistic and unachievable. However, the takeaways from the pandemic have highlighted the need for widespread, functional, and meaningful health and biology literacy with some coverage of chemistry and physics, and a greater focus in critical science literacy [5] for individuals, and for society as a whole, to engage sufficiently with STEM knowledge and how science operates. A more realistic approach to 'STEM education for all' with more appropriate and achievable goals could thus enable the individual to function in the society and form informed decisions on a number, yet limited in range, socio-scientific issues.

Keywords: Science Literacy, STEM for All, COVID-19 Pandemic



Concept of a Public Outreach Project on PCET Reactions

Christoph Weidmann¹, Larissa Hahn², Pascal Klein², Thomas Waitz¹

University of Göttingen, Institute of Inorganic Chemistry, Department of Chemistry
Education, Germany¹

University of Göttingen, Institute for the Dynamic of Complex Systems, Department for
Physics Education, Germany²

Abstract

Reactions involving proton-coupled electron-transfer (PCET) steps are of enormous relevance for processes in biology and chemical industry. Furthermore, PCET is the key to enable and optimize the most important reactions for the transition to a sustainable future: Electrochemical nitrogen fixation and CO₂ reduction involves PCET and therefore its detailed understanding as well as the development of optimized catalysts (both heterogenous and homogenous) is the overarching goal of a proposed collaborative research center (CRC) based in Göttingen with participating institutions from all over Germany.

However, despite the relevance of PCET for processes that are already taught in school e.g., photosynthesis [1] and water electrolysis, the importance of coupled proton and electron transfer for these processes is rarely known and not explicitly mentioned. In this contribution, we will present our science outreach strategy to make basic principles as well as recent results from fundamental research on PCET more visible to the public. Our outreach measures include teaching materials and educational offers targeting both school students and the general public. They will consist of a “PCET portfolio” with curricular valid teaching materials ranging from fundamental concepts and tools (“How to read a Pourbaix diagram?”) to adapted experiments and literature [2] closely related to the actual research (e.g., electrochemical functionalization of hydrocarbons [3]). Targeting the general public, we develop exhibitions for science museums and public events in a close collaboration with participating researchers. In addition, impressions from lab work, recent publications and the daily life of young researchers will be shared via social media.

Overall, apart from communicating scientific content and to transfer knowledge about PCET, we aim to strengthen the appreciation of fundamental research and to show how interdisciplinary and collaborative research works. The latter is predominantly targeting young people to help them in their vocational orientation and motivate them to become the scientists of tomorrow.

Keywords: Science Outreach, PCET, Science Exhibition



Fostering Citizenship: Systematic Refutation of False Information in Social Media by Senior Pre-University Physics Students Using a Pedagogical Tool

Süleyman Turşucu¹, Maxime Jonker²

University of Amsterdam, The Netherlands¹
Leiden University, The Netherlands²

Abstract

In recent years, citizenship gained significance in secondary education, aiming to equip students for a changing society. This study explores the intersection of citizenship and STEM education, focusing on combatting false information on social media. Specifically, we focused on Flat Earth Society (FES) supporters, who promote beliefs conflicting with the spherical Earth concept taught in physics class. Strengthening students' resilience against such false information is crucial. The central research question addresses this challenge: "How can a pedagogical tool be developed for senior pre-university physics students to systematically refute false information on social media using their basic knowledge and skills?"

Prior to designing this tool, we investigated what grade-11 students already knew about FES. The findings revealed, among other things, a deficiency in argumentative skills and confidence in mathematical or physics knowledge related to the beliefs of FES supporters. Drawing on these findings and a literature review, we identified an existing tool that we adapted to our context. Subsequently, during a pilot study five grade-11 students applied this tool to counter specific beliefs held by FES supporters about a flat Earth on social media. Following the outcomes of the pilot study, we refined the tool. Thereafter, in the second and final study three different grade-11 students used the finalized tool to counter the same FES beliefs.

The findings following from the final study affirm the possibility of developing a pedagogical tool for students to counter false information on social media. This involves formulating a reasoned stance that includes applying basic physics knowledge, possessing sufficient argumentative skills and demonstrating critical thinking. Importantly, this reasoned stance is an indicator of citizenship in students.

We emphasize that applying basic physics knowledge to refute false information in secondary education has not been sufficiently investigated. This research serves as a foundation for further research. Our adapted tool, based on the work of other researchers, may serve as a starting point to counter other forms of false information on social media.

Keywords: critical thinking, citizenship, false information, physics, pre-university education, social media

Science Teaching Models



Conceptions of Inquiry-based Learning in High School Biology in Japan and China

Jiamin He¹, Kenichi Goto²

Toyo University, Japan^{1,2}

Abstract

In the face of the ongoing globalisation of the world, changes in industrial structures and the accompanying arrival of a knowledge-based society, countries around the world are searching for a new vision of the future of school education under the name of educational reforms. Among them, the speed of educational reform in Asian countries is tremendous, and it is a fact that Japan and other East Asian countries (including Japan) are the most important countries in the world in terms of educational reforms. Among them, the speed of educational reform in Asian countries is tremendous, and it is a fact that Japan and other East Asian countries (South Korea, Taiwan, Hong Kong, Singapore and China) have achieved in less than a century the modernisation of education that took Western countries two or three centuries to achieve slowly, drawing on the experience of Western countries. drawing on the experience of Western countries.

It was the first major revision in 10 years in Japan and the first in 16 years in China, and a major feature of the revisions in both countries was the trend towards a change in education that emphasises student enquiry and practice in order to develop a From a historical perspective, both countries have a top-down approach, with one teacher in charge of a class standing on the lectern and teaching approximately 1,000 students. However, the educational reforms in both countries aimed to move away from an examination-oriented education and shift to competency-based education.

In this study, while the emphasis is on inquiry courses, we look back at the history of education in both countries, focus on the meaning of inquiry activities as defined by each country and the purpose of inquiry activities, explore what kind of inquiry education is unique to Japan and China, and in the process, formulate a unit plan for high school biology that cultivates scientific inquiry skills that fits the education in both countries, and develop a The aim is to create a high school biology unit and a concrete lesson plan that fosters scientific inquiry skills that fit the education in both countries. education in both countries.

Keywords: *inquiry learning, history of education, teaching vehicles, curricula.*



Problem Solving Processes in Science Education: Integrating the Representational Pluralism Perspective

Alexandre Hagan¹, Patrice Potvin², Michel Bélanger³

Université du Québec à Montréal, Canada^{1,2}

Université du Québec à Rimouski, Canada³

Abstract

Theoretical problem solving (PS) in science education is considered as a source of difficulties for many students and a consequently an important challenge for teachers. We argue the activity of PS in science can be considered as a modeling process in its essence. Recent studies highlighted a link between inhibitory control processes and students' difficulties during the PS. However, we don't know a lot about the epistemology of this link and how inhibitory control influences the modelling process of PS. Moreover, in science education, several models of PS have been proposed by researchers in science education and mathematics education. These models identify a number of difficulties encountered by students in PS. However, to our knowledge, these models do not integrate neither students' plurality of representations nor a dual process approach to reasoning. We believe that the perspective of representational pluralism can offer new opportunities to a better understanding of the PS in science education.

Keywords: *Problem solving, Modeling process, Science education, Inhibitory control, Representational pluralism, Dual process of reasoning*

Special Needs



The Self-Management of Home Therapy: When Creativity and the Art of Doing Become Conditions to Be Amazed

Sabrina Grigolo¹, Carla Bena²

PhD Student - University of Turin and Patient expert EUPATI - Accademia del Paziente
Esperto EUPATI, Italy¹
Director Home Care Services, ASLTO4, Italy²

Abstract

The self-management model considers the dynamic and complex phenomenon of polytherapy linked to three dimensions: context, process and outcome. In particular, contextual factors are those that influence the involvement of individuals and families in their outcomes. The process of self-management refers, however, to the use of self-regulation skills to manage chronic disease conditions or risks associated with them. These processes include activities and goals, self-monitoring, reflective thinking, decision making, planning, and engaging in specific self-evaluative behaviors of several dimensions, including affective-emotional and cognitive, important for behavior change. Furthermore, self-management can contribute to increasing the activation of the patient and caregiver in the dimension of contextual adaptation to prescriptions in terms of mnemonic strategies, drug conservation and self-care.

The aim of this research is to understand if the narrative interview should facilitate the understanding of the features of therapeutic adherence.

Methods and materials: The real-world pragmatic research with mixed methods was conducted in collaboration with ASLTO4-Regione Piemonte and University of Turin.

A sample of 23 patients and caregivers followed by the Home Care of the Chivasso District, ASLTO4 was been recruited and involved by researchers.

Keywords: polypharmacy, therapeutic education, therapeutic adherence, narrative interview

STEM Education



STEM Engaging Teaching and Learning for the Heart in Bioscience Education

Marina BA Minoli

Biologists Order Federation - STEM DidalInnovaBiolab, Italy
Royal Society of Biology, United Kingdom

Abstract

The aim of this this research and educational path was to involve high school students and science teachers in STEM integrated teaching and learning in the anatomy and physiology of the cardiovascular system with engaging, collaborative and innovative methodology to overcome a mnemonic-notional learning. This STEM innovative project connects tradition and modernity in a balanced way, guiding teachers and students in using in an integrated way different digital tools and international scientific sites. Many questions about the heart were proposed in the classes to create a “Digital Heart Debate” between the students and the group of teachers in interdisciplinary methodology approaches using also chemical mathematical equation to interpret the excitability of cardiac cells. A view of didactic work with contaminations between different disciplines and methodological strategies to promote the development of skills in integrating, comparing, identifying relationship between basic principles of the chemical, physical and biological sciences with reasoned historical elements. Considering that at different levels of educational system the learning of the anatomy and the physiology fascinate greatly, it proved very effective to create and to realize an interactive and multidisciplinary learning by doing and coworking itinerary to promote an innovative and dynamic vision of the human body in which the heart can be studied in the structural and functional complexity and in the interrelationships with other systems, to activate also original orientation teaching in Health Education. Innovative STEM and IBSE itinerary also with the historical dimension of science which is fundamental to know the steps with which science proceeds, revisiting the important discoveries useful to understand the physiology of the heart. One important objective in this future research about educational activity for students and teachers will be to promote the awareness that the life cannot be explained only at the molecular and genetic level, but that's the biological systems should be studied as complex systems that derive from dynamic interactions that operate in a coordinated manner.

Keywords: Didactic Innovation; Heart Debate; STEM Digital Teaching; Systems Biology; Orientation Teaching

The impact of the Curriculum on the Teaching of Integrated Learning (Inquiry) Time the Effects of Changing Attitudes and Developing 'STEAM Education Skills'

Kenichi Goto¹, Mika Tsuyukubo², Yorikazu Nouchi³, Katsuji Ito⁴, Hiroshi Iida⁵,
Tomoko Yoshida⁶, Yoriko Ikuta⁷, Katsuko Sanai⁸

Toyo University, Japan^{1,2}

Nihon University, Japan³

University of Teacher Education Fukuoka, Japan⁴

Shizuoka City High-School, Japan⁵

Ajime High-School, Japan⁶

Seisyo High-School, Japan⁷

National Institute for Educational Policy Research, Japan⁸

Abstract

In Japan, the Courses of Study, which will be fully implemented from 2022, set up "time for integrated learning (inquiry)" [1] in elementary, junior high and senior high schools, which integrates learning in academic subjects and other subjects. This is against the background of the promotion of 'Japanese-style school education in 2021' [2], the enhancement of STEAM education [3] and the aim to contribute to the SDGs through school education. To realize this, the Ministry of Education, Culture, Sports, Science and Technology (MEXT) has established "Teaching Methods for Integrated Study (Inquiry) Time" as a teaching subject at universities, and teacher training that enables teaching in school education is being promoted. Therefore, in this study, we would like to examine what kind of changes in awareness there are in students who have worked on the 'Methods of teaching time for integrated learning (inquiry)', including how the 'three qualities and abilities' that are shown in the 'STEAM educational ability' as qualities and abilities to be fostered are transformed. In this study, the three qualities and abilities to be developed are (i) the ability to step forward, (ii) the ability to think through, and (iii) the ability to collaborate, each of which also has a subcomponent. The curriculum for the "Integrated Learning Time Teaching Method" implemented in this report consists of 15 lessons, and the lesson plan calls for a pre- and post-awareness survey and overall information sharing (3 lessons), as well as experiential learning (4 lessons), mid-term reporting (2 lessons), lesson development (4 lessons), final reporting (2 lessons) and making a video clip of about 8 minutes.

Keywords: SDGs, STEAM education, the period for integrated studies



The Power of Science Outreach-Conscious Teachers

Veronica McCauley¹, Kevin Davison²

School of Education, University of Galway, Ireland^{1,2}

Abstract

Science outreach programs at universities have a commitment to increase student participation, in alignment with overarching goals addressing workforce shortages and broadening representation in science. However, as science departments in higher education are negotiating access to classrooms, an obvious partner is being overlooked: teachers. Social marketing's Client Principle regarding impactful behavioural change emphasises the importance of gaining a deep understanding of the specific group you aim to impact. In this respect, teachers are exceptionally well positioned to achieve this understanding, compared to some outreach practices, that parachute science engagement sporadically into the classroom. Teachers possess proximity, permanence, and a strong grasp of pedagogical theory, and as such are a powerful presence to influence change. In our work as teacher educators of science teachers over the years, we have found great value in educating student teachers about pedagogical theories that promote science engagement, such as the multiple dimensions of science capital theory. This article explores two particular dimensions. Firstly, the establishment of professional development pathways through teachers' active engagement with both industry and university settings, to promote career pathways in science-related fields. Secondly, the article delves into the integration of hook pedagogy and cognitive load theory, focusing on how these methods can effectively merge new knowledge with students' existing cognitive frameworks.

Keywords: Science Outreach, Science Teachers, Science Capital Teaching Approach; Behavioural Change, Hook Theory, Cognitive Load Theory.



Using Folding Back as a Pedagogical Design Tool Under the Lens of the Van Hiele Model with Preservice Teachers

Alberto Arnal-Bailera¹, Víctor Manero²

University of Zaragoza, Facultad de Educación, Zaragoza, Spain¹

University of Zaragoza, Facultad de Ciencias Humanas y de la Educación, Huesca, Spain²

Abstract

The well-known Van Hiele model of geometric reasoning establishes five levels of development, from level 1 (visual) to level 5 (rigor). On the other hand, the Pirie/Kieren model describes the importance of folding back processes in the learning of mathematics. This paper presents an activity implemented with mathematics teachers in training, which promotes folding back processes through the use of Van Hiele's level 5 and 4 tasks. Our results show how working with Van Hiele level 5 tasks favors reflection on similar level 4 tasks, leading to a greater depth in the reasoning of the latter. We consider that this type of activities can be especially useful in the case of students at a certain level showing some weaknesses typical of previous levels.

Keywords: Van Hiele model, Geometric Reasoning, folding back, Preservice Mathematics Teachers

Sorting Materials Using Programmable Lego[®] Robot: An Educational Activity to Promote Sustainability among Youngsters

Andrea Ienco¹, Bruno Tiribilli², Chiara D'Errico³, Armida Torreggiani⁴, Valentina Biasini⁵, Sabrina Gualtieri⁶, Pietro Galizia⁷

Consiglio Nazionale delle Ricerche, Istituto di Chimica dei Composti Organo Metallici (CNR-ICCOM), Italy¹

Consiglio Nazionale delle Ricerche, Istituto dei Sistemi Complessi (CNR-ISC), Italy²

Consiglio Nazionale delle Ricerche, Istituto di BioEconomia (CNR-IBE), Italy³

Consiglio Nazionale delle Ricerche, Istituto per la Sintesi Organica e la Fotoreattività (CNR-ISOF), Italy⁴

Consiglio Nazionale delle Ricerche, Istituto di Scienza, Tecnologia e Sostenibilità per lo Sviluppo dei Materiali Ceramici (CNR-ISSMC), Italy^{5,6,7}

Abstract

Educational robotics is a powerful, flexible, teaching and learning tool. At the same time, it can be used for presenting scientific concepts and it can help to develop scientific thinking, inquiry practice, information literacy competences, and attitudes and accountability as well as the environmental awareness. In the framework of the European Green Deal and the national project "Change the Game: Playing to Prepare for the Challenges of a Sustainable Society", we engaged groups of students in two learning paths focused on building and programming robots able to face the material recognition and recycling. The pathways were developed in two weeks' extracurricular stage in institutes of the Italian National Council of Research (CNR) and were based on colour sensing, deal with the sorting of different materials: (i) plastic caps and (ii) mosaic tiles. Lego[®] Spike Essential kit were used as hardware and software tools. The learning paths began with an introduction to the scientific topic. During the two weeks, meetings were organized with other researchers and experts and the pathway continue with the mechanical construction and programming of the robot. Finally, the students presented their creations to the public. In the case of the robot sorting caps, colour selection allows the efficient recycling of plastic (HDPE) for the production of new objects with well-defined colour characteristics. As regards mosaic tiles, they are often obtained from production residues that are marketed in the bags of multicolour fragments. The need therefore arose to automatically separate the glass tiles based on their colour to relieve the artist from this tedious task. Different convincing solutions both in the mechanical assembly and in the software development, have been obtained thanks to the creative work of the groups. At the end of their extracurricular stages the students have been asked to run a workshop in which they presented their robot projects to small groups of other students and helped them build and program the robots, thus reinforcing their skills and transferring them to their peers, in a virtuous learning circle.

Keywords: STEM, LEGO, Recycling, Sorting, School, Educational Robotics



Exploring the Digital Landscape of STEAM Learning Discourse: Insights from GPT-4 based Twitter Data Analysis

Sherif Abdelhamid¹, Elijah Bass²

Virginia Military Institute, United States of America^{1,2}

Abstract

Twitter, now known as X, is a leading social networking and microblogging platform that serves as a prolific data repository, capturing conversations on various topics through its extensive collection of user tweets. This diverse dataset provides new perspectives and valuable information about science, technology, engineering, arts, and mathematics (STEAM) education across various educational levels. However, the high complexity, unstructured format, and large volume of this data often pose significant challenges for researchers seeking to extract meaningful insights using qualitative or quantitative approaches.

To address these challenges, we leverage the Generative Pre-trained Transformer 4 (GPT-4), an advanced multimodal large language model (LLM), to analyze tweet data. GPT-4's advanced natural language processing capabilities allow it to understand and interpret the nuances of human language, including slang, abbreviations, and context-specific language often found in tweets. GPT-4's ability to infer meaning from limited text makes it ideal for analyzing such concise and sometimes cryptic messages. Additionally, GPT-4 can perform semantic analysis, identifying themes, topics, and sentiments within tweets. Finally, GPT-4 has been trained on a diverse large text corpus, which includes content from various cultures, enabling it to understand and analyze tweets from a wide range of global users, which is critical given Twitter's international user base.

Overall, this research provides two contributions: (i) a view of the new perspectives and topics related to STEAM education and (ii) a novel approach to education-related tweet data analysis using GPT-4. The data analysis findings provide pedagogical guidance to STEAM education researchers, faculty members, administrators, and policymakers on the latest trends and main topics related to STEAM education. The generated tweet dataset can also support linguists and computer scientists working in the areas of artificial intelligence and large language models.

Keywords: Chatbot, GPT-4, Twitter Analysis, STEAM Education, Social Media Network



Laboratory Teaching Proposal on the Characteristics of an RC Circuit

Ninfa Radicella

Liceo scientifico Filippo Silvestri, Portici (NA), Italy

Abstract

This abstract outlines a teaching proposal devised for a fifth-grade scientific high school class in Italy (13th grade) focusing on the behaviour of an RC circuit. By using a constructive approach, it enables students to explore and analyse the properties of an RC circuit, focusing on the behaviour of capacitors and resistors in series, and to understand the transient response of the circuit. Through exploratory teaching methodologies involving both practical experimentation and theoretical discourse, students delve into the process of charging and discharging of a capacitor, the concept of time constant (τ) and its significance in RC circuits, and - through data analysis techniques - to visualise and interpret voltage-time graphs. The tools facilitating this interdisciplinary proposal, spanning physics and mathematics with potential extensions into other scientific domains, include virtual simulators, low-cost circuit construction materials, free data analysis software, and digital sensors. All activities are highly adaptable, allowing for selective experiment execution and material utilisation. Evaluation of the pathway employs a process-oriented approach, combining observational and summative assessments within the final report.

Keywords: RC circuit, physics lab, exponential fit, active learning strategies



PBL Application to STEAM Education Incorporating Sustainability and Gender Equality Axes: STEAM-ACTIVE Project Implementation in University and High School

Kristina Zuza¹, Ane Portillo-Blanco¹, Edurne Iturbe-Zabalo², José Gutierrez-Berraondo², Spiros Sirmakessis³, Lorenzo Trombetti⁴, Simona Zoncheddu⁵, Linda Barelli⁴

University of the Basque Country (UPV/EHU), Spain¹
Fundación para la Formación Técnica en Máquina Herramienta, Spain²
University of Peloponnese, Greece³
University of Perugia, Italy⁴
Liceo Statale Assunta Pieralli Perugia, Italy⁵

Abstract

Nowadays, students in the scientific-technological field are required to achieve an inter-disciplines competence with attention also to environmental, economic and social awareness issues enabling future technicians to the required challenge-driven approach. Therefore, also a nexus between sciences and humanities is strongly encouraged since the integration of different disciplines produces a holistic approach that enables to better understand real-world problems.

In consideration of what above the STEAM-ACTIVE project (KA2-Erasmus+) proposes an innovative problem-based learning (PBL) methodology, for Teaching Learning Sequences (TLS) design, which implements an active learning approach and incorporates two main transversal axes to be considered throughout the entire process: sustainability and gender equality.

The developed methodology has been deeply formalized in a Protocol, developed for Teachers in the scientific-technological Higher Education. Also an e-learning-based training course for teachers has been realized to support their training. The Protocol, which includes a preliminary theoretical description of STEAM approaches and active methodologies' implementation, guides the teachers in the TLS design process passing through relevant steps as i) definition of the problem to be solved; ii) identification of learning objectives that students should achieve; iii) assessment of learning demands; iv) guiding questions; v) design of activities; vi) assessment of the achievement of each learning objective. In addition, the Protocol gives guidelines on techniques to adapt the TLS to different education contexts.

The e-learning course has been reviewed by external university teachers. Moreover, a collection of 24 STEAM-based TLS has been designed by applying the Protocol and internally reviewed. Part of the designed TLS have been already tested being the project entered the piloting phase.

Globally, the STEAM-Active project enhances students' ability to integrate different disciplines in solving a technical problem taking into account though all the solving process also the social impacts their decisions have. Moreover, it contrasts gender gap in the STEM field increasing women's participation. For this also its application to the high school is preliminary assessed.

Keywords: STEAM, STEM education, PBL, active learning, gender equality, circular economy



Experiences and Struggles of Female STEM Students: Insights from a Women-Only STEM Program

Sandra Klatt¹, Martha King², Ulrike Busolt³

Furtwangen University, Germany¹

Memorial University of Newfoundland, Canada²

Furtwangen University, Germany³

Abstract

In many STEM fields, especially computer science and engineering, women are vastly outnumbered in undergraduate education. This becomes even more noticeable in further education and the workforce. The gender difference is the most pronounced in high-level positions, a phenomenon often referred to as the 'leaky pipeline' [1; 2]. While the underrepresentation of women in STEM is often investigated starting at a very young age on topics such as spatial knowledge, learning methods, and stereotypes [3], university education is a critical time when female students will become familiar with many of the struggles faced by women in STEM, and ultimately decide to drop out of their studies or not.

In this paper, questionnaire results are analyzed from an annual German women-only STEM summer school (informatica femminile Baden-Württemberg) targeted at computer science students and professionals, and an annual winter school (meccanica femminile) targeted at female mechanical and electrical engineering students and professionals. These results provide important insights regarding female STEM students including motivation, discrimination, dropout and retention, and the importance of a mono-educational environment. By providing insight into the struggles' female STEM students face, their reasoning for potentially dropping out or leaving the field becomes much clearer, as do potential solutions to help with these issues.

Keywords: Mono-Education; Women in STEM-studies; Dropout of female STEM-students

Student Assessment



Senac University Center Leveling Program – An Experience that Integrates Knowledge and Creativity

Luciana Mara Ribeiro

Senac University Center, Brazil

Abstract

In Brazil, all levels of education present a historical deficiency and this situation was worsened during the pandemic that occurred in 2020, with one of the impacts on Higher Education Institutions being the learning gap presented by incoming students, who had part of the content of the High school committed to the absence of basic subject classes. According to Barreto (2013), the deficiencies brought by the student, especially with regard to reading and interpreting texts and writing, are perceived in the most varied areas of university knowledge and involve the entire academic career. This fact contributes, therefore, to high rates of poor university training, a negative factor that leads us to reflect on ways to improve the quality of education and, consequently, reduce social inequality, seeking possible solutions to these difficulties faced by students entering education. higher. Faced with this situation, the Centro Universitário Senac, located in São Paulo, with 38 undergraduate courses from different areas of knowledge and around 8,000 students, improved its leveling activities, seeking to develop more attractive and differentiated activities, in addition to preparing the teaching staff. to work through these difficulties. The Leveling Program aims to enhance the knowledge of incoming students in the areas of mathematics, chemistry, physics, Portuguese language, communication and expression and the production of academic work, reducing learning difficulties in higher education courses and contributing to their academic journey. The schedule of activities is announced to incoming students at the beginning of the semester, in a Virtual Welcome Space and face-to-face workshops, cultural Literature events and installations with tips and content are held in campus environments, such as a literary staircase with poems on the steps, panel on mathematics on the Demoiselle plane exposed with campus and a giant periodic table in a student commons area. In this way, this work aims to share the actions and results obtained by our Leveling Program, in reducing students' difficulties in the learning process, and consequently, in reducing evasion, and also in encouraging reading, something that contributes to professional training of students in all areas of knowledge.

Keywords: Higher Education; leveling; knowledge; creativity



Students after the Pandemic: What Are the Differences in their Achievement Motivation and Metacognitive Skills?

Patricia Morales Bueno¹, Rosario Santos Rodas²

Pontificia Universidad Católica del Perú PUCP, Perú¹

Pontificia Universidad Católica del Perú, Perú²

Abstract

The return to in-person work, in educational institutions and in particular in universities has highlighted the impact of the pandemic on many aspects of the students' profile. The changes observed are very diverse and involve aspects related to behavior, social skills, learning skills, the use of technology, among others. This has motivated the development of research that seeks to identify and quantify the impact of the pandemic on students. However, the results are very variable, since they depend on the geographical, social, and educational contexts where the research has been carried out. The review of pedagogical strategies to work with students who begin their training at the university implies knowing their main characteristics and, in that sense, two variables that are fundamental in the academic performance of students are academic motivation and metacognitive skills. In this sense, the purpose of this work was to compare the profile of two groups of students in terms of these two variables. For this, the Modified Achievement Motivation Scale (EAML-M) and the Metacognitive Awareness Inventory (MAI) were applied. Both groups included students who were beginning their studies in Science and Engineering careers at a Peruvian university. One of the groups included students from a semester prior to the pandemic, and the second group included students who began their studies in the return semester after the pandemic. The results showed significant differences in favor of pre-pandemic students in metacognitive skills that are related to the regulation of cognition, that is, with the activities that help control the learning process. These results constitute a contribution to the planning of pedagogical strategies with students who are beginning their university studies.

Keywords: Achievement motivation, metacognitive skills, pandemic, higher education



Exploring the Development of Questioning Inquiry Skill in Secondary School Students via Physics Inquiry-Based Learning Experiments

Vasileios Gkagkas¹, Euripides Hatzikraniotis²

Aristotle University of Thessaloniki, Thessaloniki, Greece^{1,2}

Abstract

Science process skills encompass cognitive abilities for evidence-based inquiry, integral to inquiry-based learning, promoting holistic development and academic success. The current study aims to assess Grade 10 & 11 school students in the "Identify Testable Questions" inquiry process skills based on the Science Inquiry Skills Framework after participating in inquiry-based learning activities. Three inquiry-based learning series (confirmatory, structured, and guided) were developed, focusing on "Newtonian Mechanics," with small groups of 3-4 students on a total N=22. Students' responses were categorized into four levels based on their epistemological accuracy. The study's findings indicate that students' performance steadily improves in each inquiry type, which is evident in rising the average values. Significant variations were uncovered through paired samples t-tests, with Structured inquiry yielding higher mean scores than Confirmative inquiry and Guided inquiry outperforming Structured inquiry. Hake Gain indices demonstrated a medium gain ($g=.39$) between initial and final assessments for Guided inquiry. The assessment results underscored the diverse effectiveness of each inquiry type, emphasizing the time and engagement required for notable skill improvement. Open-ended question analysis revealed five distinct response patterns, showcasing a positive transformation in students' explanations aligned with established scientific knowledge. The study highlights the pedagogical value of guiding students through progressively advanced inquiry types, contributing valuable insights to the discourse on effective inquiry-based learning practices and their impact on scientific skill development.

Keywords: Science Process Skills, Inquiry-Based Learning, Student Performance

Student Conceptions



Reflecting on School through the Voice of Children

Dárida Fernandes¹, Catarina Ribeiro², Paula Quadros-Flores³, Ana Luísa Pinto⁴

*School of Education of the Polytechnic Institute of Porto, Portugal^{1,2}
Escola Superior de Educação - Instituto Politécnico do Porto, Portugal³
Unidade Local de Saúde do Nordeste, Portugal⁴*

Abstract

School is a place for learning and, at the same time, for individual and social growth. But what do children think of this space for socialising and learning? In order to understand this first-person experience, an investigation was carried out as part of the Teaching and Learning Practices for the Master's Degree in Teaching the 1st Cycle of Basic Education (CEB) and Maths and Natural Sciences in the 2nd CEB at the Polytechnic School of Education in Porto, with a group of 50 students aged between 8 and 12, belonging to one class in the 1st CEB and two in the 2nd CEB. Given the pandemic period, in which the school existed in E@D mode, the aim was to give the child a voice, understanding "what do children think of the school?". The focus of the study was on the concept of school, encompassing three dimensions: i) the building; ii) the school institution; iii) the classroom, in a close relationship between pupils and teachers. This is a case study that includes qualitative and quantitative approaches, using various information gathering resources to enable data triangulation: direct and participant observation; supported narrative diaries; (in)formal dialogues with the children; questionnaire surveys; individual and collective interviews and duly planned and implemented classroom moments. The discussion of results reveals that the concept of school, from the children's point of view, is quite comprehensive, identifying the building as a place to play, socialise and grow interpersonally and intellectually. The children see it as their mission to search for places within the school to study and learn what the teachers are teaching.

Keywords: Education; Listen to children; Learn; School; Relations

Teacher Professional Development



Comparison of Mathematical Activities with Preservice Teachers: Manipulatives vs. Paper and Pencil

Alberto Arnal-Bailera¹, Mónica Arnal-Palacián²

University of Zaragoza, Spain^{1,2}

Abstract

In the Spanish Primary Education curriculum, basic arithmetic properties are first introduced in the 3rd and 4th grades. Working with arithmetic expressions gives rise to relational thinking, which connects the algebra with the generalization of patterns and relationships. Hence, it is of vital importance to also consider arithmetic properties in the training of preservice teachers encompassing both scientific and pedagogical dimensions (MKT, Mathematical Knowledge for Teaching). This communication aims to compare aspects of mathematical knowledge (in particular, Specialized Content Knowledge and Knowledge of Content and Teaching) when explaining an arithmetic property using pencil and paper versus the use of manipulative materials. The sample consists of the answers of 35 preservice teachers to the following task: "Create a written explanation that demonstrates that the arithmetic property $a:(b:c) = (a:b) \times c$ is true (a , b , and c are natural numbers)". The variables used for this new analysis of written productions were: contextualization, variety of representations, choice of numerical values, meaning of intermediate operations, and property verification. Among the results found in both analyses, some similarities can be observed, such as the significance of numbers and the choice of numerical values. However, there are also certain differences, such as the contextualization present in explanations and the meaning attributed to intermediate operations. It is clear that conducting the activity with manipulative materials requires more time on the part of the university professor. Nevertheless, it fosters more engaging experiences for PSTs and, most importantly, closely aligns with their forthcoming teaching practice.

Keywords: Preservice teachers, arithmetic properties, paper and pencil, manipulatives.



Integrated STEM Professional Development: Utilizing Best Practices in an Online Format

Sarah Haines¹, Sumreen Asim², Jeanna Wieselmann³, Deepika Menon⁴

Towson University, United States¹
Indiana University Southeast, United States²
Southern Methodist University, United States³
University of Nebraska, Lincoln, United States⁴

Abstract

Online professional development (PD) can reach teachers from widespread areas. Here, we describe PD activities that are part of a project focused on integrated science, technology, engineering, and mathematics (iSTEM) teaching self-efficacy and effectiveness among early-career elementary teachers. Toward our objective of building a community of elementary teachers focused on improving their iSTEM teaching, we are conducting online PD institutes over four summers. These PD institutes are designed using Desimone's five critical features of effective PD: content focus, active learning, coherence, duration, and collective participation. Our institutes engage teachers in an initial synchronous online session, which is followed by independent work time to put their learning into practice. It concludes with a final synchronous online session where teachers share their asynchronous work, receive feedback, and identify the next steps in enacting their learning in the classroom. Below we describe the first year's PD activities.

Keywords: professional development, science education, elementary, STEM



Embracing Multidisciplinarity: Exploring Challenges and Identities of Teachers in the Subject Integrated Sciences

Jasper Cirkel¹, Stefan Halverscheid², Susanne Schneider³

University of Göttingen, Germany^{1,2,3}

Abstract

The multidisciplinary subject “integrated sciences” has become a prevalent approach to teaching science in German comprehensive schools as a combination of the traditional science subjects: biology, chemistry and physics in the lower secondary level (grades 5-10). However, the existing teacher education system in Germany (during university and preparatory service phase) is structured around two individually chosen subjects. If at least one of their subjects is a science discipline, the teachers in comprehensive schools are expected to teach integrated science courses. As a result, it is common for teachers to find themselves teaching (partly) out-of-field of their expertise.

This study is based on semi-structured interviews involving n=15 teachers. The transcripts of the interviews are analyzed through qualitative content analysis. Using the framework of identity-research [1–4] the question as to whether teachers show a science-teacher identity versus e.g., specialist biology-teacher identity is discussed.

Keywords: out-of-field-teaching, science teaching, teacher identity

Experiences with the Teacher Training Avatar Program and the Usefulness of the Program as Seen in the Discussion

Hijiri Okinaka¹, Kenichi Goto²

Toyo University, Japan^{1,2}

Abstract

In the recent world situation, our way of life has been drastically changing due to the remarkable development of technology, evolution of AI, and pandemics caused by a new type of coronavirus. In order for our students to survive in this changing environment, we need to change the way education is provided, so that students can acquire the newly required skills and adapt to the coming age. To this end, teachers are required to improve their classes so that the learning process becomes more fulfilling. This is also stated in the new Courses of Study announced for 2017. In Japan [1], from the viewpoint of "what is to be learned," classes have traditionally been taught mainly in a teaching-intensive manner. However, as mentioned above, education needs to be transformed in accordance with the changing times. This transformation of education is a departure from the traditional teaching-intensive classes, and classes that are conscious of proactive, interactive, and authentic learning (active learning). Therefore, it is an important issue for teachers to be able to acquire the ability to conduct such classes [2]. The research team led by Dr. Tosa conducts research on active learning [3] and is developing an avatar class program suited to the Japanese educational format, based on the "Teaching Avatar Program" that is being tried in Florida, USA. In this avatar space, lessons are given to students, and teachers can practice their lessons. This is an advanced attempt in this day and age of communication technology in the avatar space. As a test subject, I experienced the Law of Conservation of Mass lesson program. I discussed with other participants the insights and transformations I gained from this experience, and clarified the outcomes and challenges. This presentation will report on the outcomes and challenges, as well as the usefulness and future potential of the program. In addition, as a member of the team, I plan to develop a classroom program in the field of biology in the future.

Keywords: Avatar, Teacher training, Proactive, interactive, and authentic learning (active learning)

A Reflective Perspective on the Initial Training in Science for Primary School Teachers at CRMEFs in Morocco

Fatima Zahra El Ouahabi¹, Rachid Drissi El Bouzaidi², Abdellah Chaiba³

Regional Center for Education and Training Professions Rabat-Sale-Kenitra,
Morocco¹

Regional Center for Education and Training Professions Souss Massa, Taroudant,
Morocco²

Regional Center for Education and Training Professions Draa Tafilalet, Ouarzazate,
Morocco³

Abstract

In Morocco, the Regional Centers for Education and Training Professions (CRMEFs) have undergone an update of the training program for teaching staff in connection with Project No. 9 of Framework Law 51.17 [1]. The Professional Training Kit for bilingual primary education leaders has been renewed as part of the development engineering preparation, led by the Higher Education Partnership Program - Morocco (HEP-M). The Kit includes a module of "Support for Basic Science Training", the main focus of this research. It aims to strengthen scientific knowledge related to the scientific awakening program among future teachers. The present study corresponds to a concrete reflective vision concerning the implementation of the module in question to enhance the standard of science education in primary schools. Its objectives include: inventorying the management modalities, determining the constraints of adopting the syllabus in the current situation, and suggesting alternatives and/or effective solutions to better manage its activities. The results are gathered from nine regions using an online questionnaire consisting of 23 questions, addressed to life and earth science as well as physical science teacher-trainers involved in teaching the module at various CRMEFs across Morocco kingdom. The obtained results support the partial adoption of the syllabus in question. These findings argue in favor of the implementation of the "Support for Basic Science Training" module, which relies on a wide range of concrete and digital resources. However, the surveyed teacher-trainers have shown limited emphasis on the flipped classroom approach. Similarly, limited attention has been given to practical work and supporting self-training due to several constraints. In this study, we present the following preliminary recommendations for effective activity management: Introduce MOOCs in sciences to streamline the incorporation of the flipped classroom approach and guarantee assistance for self-directed learning; Guide the self-training of aspiring teachers; Supply well-equipped laboratories to ensure the practical work's feasibility; Review the entry requirements for CRMEFs; Reduce class sizes, and Establish a platform for collaboration and communication among science educators on a national scale.

Keywords: Morocco, Management Modalities, Sciences, CRMEFs, Professional Training Kit, Syllabus

The Scientific Committee of the International Conference “New Perspectives in Science Education - 13th Edition”

Börge Kummert - Campus02 - Fachhochschule der Wirtschaft (Austria)

Tereza Trencheva - State University of Library Studies and Information Technologies (SULSIT) (Bulgaria)

Tania Todorova - State University of Library Studies and Information Technologies (SULSIT) (Bulgaria)

Milena Koleva - Technical University of Gabrovo (Bulgaria)

Thomas Waitz - Georg-August-University Göttingen (Germany)

Timm Wilke - Carl von Ossietzky Universität Oldenburg (Germany)

Tobias Schmohl - OWL Technical University of Applied Sciences and Arts (Germany)

Dionysios Koulougliotis - Ionian University (Greece)

Michail Kalogiannakis - University of Thessaly (Greece)

Marie Walsh - Technological University of the Shannon (Ireland)

Aharon Gero - Technion, Israel Institute of Technology (Israel)

Sabrina Grigolo - University of Turin and Patient Expert EUPATI - Accademia del Paziente Esperto EUPATI (Italy)

Luisa Panichi - University of Pisa (Italy)

Elisabetta Delle Donne - Pixel (Italy)

Marina Minoli - Royal Society of Biology (United Kingdom); Biologists Order Federation, STEM DidalInnovaBiolab (Italy)

Martin Musumeci - University of Malta (Malta)

Filomena Barreiro - Instituto Politécnico de Bragança (Portugal)

Anca Colibaba - GR. T. Popa University / EuroED Foundation (Romania)

Stefan Colibaba - Al. I. Cuza University (Romania)

Fuad Aleskerov - HSE University (Russian Federation)

Murat Demirbas - Kirikkale University (Turkey)

Siobhán O' Sullivan - College of Medicine and Health Sciences, Khalifa University (United Arab Emirates)

Nikolaos Fotou - University of Lincoln (United Kingdom)

Nasser Mansour - Exeter University (United Kingdom)

Péter Tasi - Aston University (United Kingdom)

Michael Taber - Colorado College (United States)

Diane Boothe - Boise State University (United States)

Melissa Caspary - Georgia Gwinnett College (United States)



EDITED BY
PIXEL

Via Luigi Lanzi, 12 - 50134 Florence (Italy)

Tel. +39 055 489700 - E-mail: science@pixel-online.net

Conference website: <https://conference.pixel-online.net/NPSE/>

ISSN: 2384-9509

ISBN: 979-12-80225-58-0

EURO: 20,00

