4th World Conference on Physics Education 2024, Kraków, Poland

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Book of Abstracts

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IPER 2022 –A study conference on Physics Education Research in Italy

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Corresponding Author: marco.giliberti@unimi.it

Italian Physics Education Research (IPER) groups decided to create a Community (CooFIS08) to share and compare studies, to promote the role of PER at all levels. Despite international recognition, PER in Italian Physics Departments lacks adequate domestic support, relying on external funding. In 2022, Angela Bracco, President of the Italian Physical Society, endorsed CooFIS08's proposal for a Udine conference to discuss IPER's research and bridge the research-practice gap. The sixteen research contributions covered content, teaching, social, epistemological aspects, teacher education, physics history, informal education, and collaboration, aiming to support PER in Italy. This presentation will delve into them.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

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Story Games as a Stimulus for Experimental Activity

Author: Tatiana Sukeľová[None]

Co-author: Klára Velmovská [1]

[1] *Faculty of Mathematics, Physics and Informatics, Comenius University in Bratislava, Slovakia*

Corresponding Author: tatiana.sukelova15@gmail.com

In this contribution, we focus on the Story game as a stimulus for experimental activity. Storytelling is prevalent in education, hence our decision to incorporate storytelling into the game. We conducted a survey in which we observed sessions involving our created Story game alongside a Standard assigned experiment, aiming to assess whether the Story game is a suitable stimulus for experimental activity. Based on the questionnaire survey, we can conclude that the Story game serves as a suitable stimulus for experimental activity.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **169**

Provincial physics competition as a tool for reflection on physics competences in Polish primary schools –case study

Author: Marta Mlynczyk[1]

Co-authors: Mirela Kaczmarek [2]; Paweł Nowak [3]; Tomasz Greczyło [2]

[1] *Nauczyciel fizyki w Liceum Ogólnokształcącym Nr XII im. Boleslawa Chrobrego we Wroclawiu*

[2] *University of Wrocław*

[3] *Wroclaw Board of Education*

The article presents a preliminary idea of how local physics competitions serve as a platform for assessing physics competencies, especially among gifted Polish elementary school students. Focusing on the provincial "zDolny Ślązak" competition, the authors will analyze the participants'solutions to the competition tasks together with the students' physics competencies, especially those related to experimental tasks and solving computational tasks.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Formal Education

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A quantum mechanics educational proposal implemented in the INSPYRE School

Authors: Adriana Postiglione[None]; Catalina Oana Curceanu[1]; Marisa Michelini[None]; Lorenzo Santi[None]; Angelo Bassi[2]; Susanna Bertelli[3]

[1] *INFN e Laboratori Nazionali di Frascati (IT)*

[2] *University of Trieste and INFN*

[3] *INFN Frascati National Laboratory*

Among the non-formal educational initiatives that enable students to enter places where scientific research is realized, the INFN-INSPYRE is an International School of excellence, reaching more than

600 people from 17 countries around the world since 2011. For its 2024 edition, the school will benefit of the collaboration with the physics education research and outreach community of GIREP and CERN. Here we present the quantum mechanics didactic proposal implemented in INSPYRE 2024 with 40 students of 7 countries and planned in the context of the collaboration between INFN researchers and physics education researchers of GIREP and specifically of Udine Group.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Non-formal Education

Oral presentations / 212

Preservice Physics Teachers' Challenges in Laboratory Practice

Author: İrem Gezer[1]

Co-authors: Simay Köksalan [1]; Ufuk Yıldırım [1]

[1] *Middle East Technical University*

Corresponding Author: kuli@metu.edu.tr

This study focuses on investigating the challenges encountered by preservice physics teachers (PPTs) in using two different methods for the same investigation using a structured inquiry activity. Eight PPTs will be working in pairs to investigate the image formation in plane mirror activity. Data sources include answers to pre-quiz, laboratory reports, video recordings of laboratory practice, and group interviews with students after the experiment. Based on the analysis of the data, we will discuss challenges that PPTs encounter when they investigate the topic using different experimental methods. Also, suggestions and implications will be presented.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 205

Professional Development Programs in Physics in Tuscany

Authors: EMILIO MARIOTTI[1]; Vera Montalbano[2]

[1] *Università di Siena*

[2] *University of Siena*

Since 2000 we have been engaged in professional development programmes to improve the cultural knowledge and skills of pre-service and in-service teachers. All activities focus on promoting active learning in laboratories. After testing different training modalities for in-service teachers, in recent years a series of national summer school has been organised to explore a single general topic from an interdisciplinary point of view. In addition, in collaboration with an interdisciplinary inter-university team, we have developed and tested a training course for tutors for newly recruited teachers in Tuscany, with the aim of promoting the acquisition of professional skills.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Informal Education

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From probabilities to Bell's inequalities: a pathway for secondary school quantum literacy

Author: Valentina DE RENZI[None]

Co-authors: Maria Bondani [1]; Matteo Paris [2]

[1] *CNR - Institute for Photonics and Nanotechnologies*

[2] *INFN - National Institute for Nuclear Physics*

Quantum Mechanics (QM) is a cornerstone of modern science and technology, yet its complexities have hindered its integration into school curricula. We propose a QM teaching/learning sequence for secondary schools that focuses on Bell's inequalities and their experimental verification, and outline a step-by-step approach, leveraging on students' existing knowledge of statistics and probability. Through hands-on activities, such as the demonstration of a simplified card game, and discussions of CHSH experiments, we clarify the main differences between classical and quantum probabilistic predictions. Preliminary results from informal and formal test sessions indicate promising results, suggesting the effectiveness of our approach.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

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Identifying student interpretations of quantum mechanics in upper tertiary education

Authors: Freek Pols[None]; Rutger Ockhorst[None]

Despite quantum mechanics' significant role in technological advancements, its interpretations remain a subject of ongoing debate among scientists. In this study we examine the evolution of student perspectives on quantum mechanics interpretations during an elective course on the subject in upper tertiary education. We focus on identifying changes in student thinking and developing an instrument for teachers and students to examine their own views on various aspects of interpretations of quantum mechanics, such as realism and locality. In this presentation we present our preliminary findings.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

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Innovative teaching methods used by the employees of the University of Wrocław –case study from the perspective of Faculty of Physics and Astronomy

Author: Tomasz Greczyło[None]

Co-author: Jacek Brona [1]

[1] *University of Wroclaw, Faculty of Physics and Astronomy*

Corresponding Author: jacekb@ifd.uni.wroc.pl

The article presents a study mapping the teaching methods used by employees at the University of Wrocław. Conducted via a questionnaire from the ARQUS initiative—a European university consortium—the research analyzed the responses of the Faculty of Physics and Astronomy compared to other departments. This analysis highlighted similarities and differences in teaching declarations, resulting in a database of good practices involving active teaching methods and identifying university employees who use these methods in their work.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

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Cultural understanding of quantum physics through a historical and pedagogical reconstruction of Old Quantum Theory and early Quantum Mechanics

Authors: Luisa Lovisetti[1]; Marco Giliberti[2]

[1] *University of Milan, Department of Physics*

[2] *Università degli Studi di Milano*

Corresponding Author: luisa.lovisetti@unimi.it

In a society where technological applications risk overshadowing the true essence of physics, understanding historical and epistemological aspects becomes crucial for a meaningful and cultural introduction to quantum physics (QP). In this sense, we believe that exclusively presenting Quantum Mechanics (QM) when introducing QP (especially at high school) may prove insufficient, and we emphasize the importance of dealing also with the Old Quantum Theory, as it provides insights into the cultural relevance of QM, facilitates a deeper reflection on the Nature of Science, and aids also in understanding the physics-related QM problems. In this presentation we will discuss these aspects.

How would you like to present your contribution?:

Hybrid from my own country (early in the conference day, best for Asia, Australia)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 133

Perceptions of high school leaners' difficulty with kinematics graphs

Author: Itumeleng Phage[1]

[1] *Central University of Technology, Free State*

Learners in schools seem to have difficulty with conceptual understanding and problem-solving in kinematics graphs. The study investigated what are the learners' perceptions on the teaching and learning of kinematics graphs, and to find out from them what could make them enhance their learning and performance. A purposeful sand random study was done with Grade 11 leaners doing physical science and mathematics using a questionnaire. Descriptive and statistical analysis was done. The results indicated that learners only learnt to pass kinematics without conceptual understanding and struggled to relate it to algebra.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **270**

Evaluating in-service teachers pedagogical content knowledge for teaching physics

Authors: Eilish McLoughlin[None]; Stephen Gammell[1]

[1] *Dublin City University*

This study presents the results of an evaluation of a teacher professional learning summer school, designed to develop the in-service science/mathematics teachers pedagogical content knowledge (PCK) for teaching physics. Workshops were facilitated online on a range of topics, including active learning, catering for diverse learners, formative and summative assessment, making connections, digital technologies, and the use of research to inform practice. Findings from a thematic analysis of units of learning designed by teachers will be discussed and provide insights into the influence of this programme on in-service teachers PCK for teaching physics.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

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Designing a Tinkering Workshop: Empowering Teachers Demystifying the Design Process

Author: Sara Ricciardi[1]

Co-authors: Irene Giovanardi [2]; Stefano Rini [2]

[1] *INAF OAS*

[2] *University of Bologna*

This work aims to guide educational communities in creating tinkering workshops from scratch. Such a process demystifies and makes the design of these workshops accessible, positioning teachers as the true owners of the initiative. If we consider tinkering workshops not as isolated events but as venues to provoke, amplify, and potentially address children's inquiries about science, it becomes crucial for teachers to independently plan this enriching and engaging moment as a community of educators. We developed the RAPA design cycle and tested it end to end, working with a heterogeneous group of designers.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Formal Education

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A new teaching-learning sequence of quantum physics via Michelson interferometer using the Dirac notation

Author: Kristóf Tóth[None]

Co-authors: Fabian Hennig ; Philipp Bitzenbauer

There are many ways to introduce quantum mechanics to secondary school students. In the last decades two-state approaches became popular. These may have the disadvantage of being less compatible with traditional approaches (wave-particle duality) and thus not overlapping with the school curriculum. In this presentation we show a new way based on the single photon interpretation of Michelson interferometer that provides the possibility to give a two-state description that fits perfectly to the wave-particle duality, using the Dirac notation, trickily bypassing the complex phases.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

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Teaching Thinking-Back-and-Forth in Practical Work: an Educational Design Study in Secondary Education

Author: Wouter Spaan[None]

Co-authors: Jaap Schuitema ; Monique Pijls ; Ron Oostdam

Corresponding Author: w.p.spaan@hva.nl

Practical work provides the opportunity for students to make a connection between hands-on activities and minds-on concepts. In this study, lesson design principles were investigated for stimulating Thinking-Back-and-Forth (TBF) between hands-on and minds-on aspects. Nine practical lessons intended to stimulate minds-on learning experiences were designed. These lessons contained an assignment and guidance aimed at stimulating TBF and mitigation of the cognitive load of hands-on aspects. Student learner reports were evaluated for reported minds-on learning, and the lessons were video-recorded. Results show that the design principles stimulate minds-on learning. Therefore, educational practice can benefit from using the design principles described.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

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Boosting Problem-Solving Skills in Physics Classes: Conceptual Understanding Through Context-Rich Problems

Author: diana domenichini[1]

Co-authors: Filippo Chiarello [1]; Gualtiero Fantoni [1]; Marilu Chiofalo

[1] *University of Pisa*

Corresponding Author: diana.domenichini@phd.unipi.it

Physics Education Research (PER) seeks to address students' struggles with problem-solving in physics by introducing innovative educational methods. This study proposes using a conceptual problem-solving (CPS) framework to tackle context-rich problems (CRPs) in physics courses of life science disciplines. CRPs have an alternative and misleading narrative, and the CPS framework prioritizes qualitative understanding over quantitative solutions. We aim to investigate university's students' perceptions and outcomes, focusing on gender and knowledge transfer abilities.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

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Design for Physics

Author: Giovanni Organtini[1]

Co-authors: Gianfranco Bombaci [2]; Mauro Del Santo [2]

[1] *Sapienza Universita e INFN, Roma I (IT)*

[2] *IED: Istituto Europeo di Design*

Design for Physics is a joint project between a physics department and a design institute, aiming at engaging students that feel uncomfortable with scientific disciplines in the exploration of science.

Students at IED were asked to design, produce and test low cost and easy to make apparatus for physics experiments, to be used in schools for teaching. We report about the project organisation, results and about the studies we conducted observing the students. We also tested the resulting products with a group of physics teachers, whose impressions are reported. Prototypes were exposed at important fairs, attracting a lot of interest.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 307

Elementary particles in an introductory course on quantum mechanics

Author: Ivan Melo[1]

[1] *University of Žilina*

Corresponding Author: ivan.melo@feit.uniza.sk

I review popular definitions of elementary particles and argue that their description as excitations of quantum fields has its place in an introductory course on quantum mechanics at universities and can be further simplified to satisfy curiosity of motivated high school students.

How would you like to present your contribution?:

Hybrid from my own country (early in the conference day, best for Asia, Australia)

Target education level:

University

Category:

Formal Education

Oral presentations / 126

Case Studies in Introductory Physics Course for Science Programs: Example of Intervention

Author: Tetyana Antimirova[1]

[1] *Toronto Metropolitan University (formerly Ryerson University)*

Case Studies are a valuable teaching tool that allows us to bring real-world scenarios, introduce a process of authentic scientific inquiry to undergraduate physics courses, and promote a genuine

collaboration among the students. Contrary to a common belief, they can be effectively used in a large-enrolment introductory physics classes. The example of Case Studies developed for the introductory physics courses for science programs will be demonstrated. The methods of measuring the impact of the case studies on students'learning will be discussed.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

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Evaluation of a teaching-learning sequence on the particulate nature of matter using crystal structures

Authors: Florian Budimaier[1]; Martin Hopf[1]

[1] *University of Vienna*

The evaluation of a teaching-learning sequence (TLS) on the particulate nature of matter (PNM) based on crystal structures is presented. The TLS has been developed in a design-based research project. To test if the TLS fosters students'use of the PNM it was introduced to several 8th-grade classes in Vienna. Students'use of the PNM was measured with a pretest and posttest. Preliminary results based on limited data suggest that students use the PNM in the posttest significantly more often. However, regarding phase transitions, most students remain in a continuous perception of matter even after the intervention.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

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Pre-service physics teachers'understanding of rates of change in the context of the undergraduate laboratory work

Author: Olga Gkioka[1]

[1] *boğaziçi*

The focus of the study is on how pre-service physics teachers have made sense of rates of change at various points of curved graphs when they analyse experimental measurements in physics lab courses. Forty-eight pre-service physics teachers participated. Data sources were open-ended written tasks, semi-structured interviews and lab reports. When talking about rates of change, the participants proposed to draw a tangent at particular points of the curve but they could not calculate derivatives at corresponding points of curves. In addition, they could not interpret rates of change to give a physical meaning to them.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 253

Tinkering in the primary school: from episode to science practice

Author: Stefano Rini[1]

Co-authors: Fabrizio Villa [2]; Sara Ricciardi [2]

[1] *University of Bologna*

[2] *INAF OAS*

This study examines the integration of tinkering, a constructivist practice, into formal education, highlighting its potential and challenges. Through the "Officina degli Errori", researchers and educators sought to blend tinkering's open exploratory nature with structured learning in primary school classrooms, focusing on Physics Education. Despite pandemic-induced limitations, feedback from 20 teachers and analysis of fishbowl protocols revealed tinkering's positive impact on classroom dynamics, teacher engagement, and student inclusion. However, teachers are often uneasy conducting scientific research with their students. These findings will guide our future co-designs to enhance learning experiences and address the complexities of incorporating tinkering into formal education.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Formal Education

Oral presentations / 22

Keep it secret, keep it safe: Teaching quantum cryptography in high-school

Author: Efraim Yehuda Weissman[1]

Co-authors: Avraham Merzel [2]; Nadav Katz [2]; Igal Galili [2]

[1] *Jerusalem College of Technology*

[2] *The Hebrew University of Jerusalem*

Quantum physics offers numerous technological applications, yet their complexity poses challenges for teaching secondary-level students. Quantum cryptography, grounded in fundamental quantum principles, presents a contemporary and accessible subject. This study investigates the impact of teaching quantum cryptography as part of the Discipline-Culture approach. We analyse the responses of 12th-grade students to open questions and final test problems to gauge their understanding of the principles of quantum physics and their motivation. Our results show that students succeed in applying the core concepts of quantum physics to new quantitative problem-solving and that teaching quantum cryptography induced motivation for learning quantum physics.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

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Student-centred reform of an Applied physics program

Author: Aleš Mohorič[1]

Co-authors: Andreja Sarlah [1]; Gorazd Planinsic [1]

[1] *University of Ljubljana*

Corresponding Author: ales.mohoric@fmf.uni-lj.si

We describe reforms in the Applied physics program at the University of Ljubljana. The reforms utilised the Investigative Science Learning Environment (ISLE) approach to a more effective learning and teaching physics. The course was synchronised with recitations and lab work, the classroom was rearranged in a studio setting to support group work, and semi-open investigations were introduced in the lab course to foster authentic experiences. Using active student participation and collaboration, the program aims to produce graduates who are equipped to tackle real-world problems. We report on various changes and attitudes of students and instructors towards the reformed programme.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

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Exam in primary school in form of practical open tasks

Author: Mikołaj Kałdan[1]

[1] *Jagiellonian University of Cracow*

Noticing disadvantages of written individual exams we have conducted research by developing practical test with group work. We wanted to determine whether it is possible to make that kind of test in class and evaluate pupils independently. Moreover we have examined other advantages of that form of test such as opportunity to learn during exam and higher engagement. Our test counted only sixteen pupils, but it is scalable to larger classes. To conclude group practical tests are harder to conduct, but by observing work of children it is possible to evaluate them instead of checking written exams at home.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Oral presentations / 266

Walk of the Planets - Students Concepts of the Solar System

Author: Maximilian Alexander Loch[1]

Co-authors: Malte S. Ubben [2]; Emmanuel Rollinde [1]

[1] *Laboratoire de Didactique André Revuz CY Cergy Paris Université, France*

[2] *Institut für Fachdidaktik der Naturwissenschaften - Technische Universität Braunschweig, Germany*

Corresponding Author: maximilianloch80@gmail.com

With the reintroduction of astronomy into the school curriculum in North Rhine-Westphalia, the question arises as to what ideas learners have about our solar system, how these may have been created and what teaching methods can be used to influence them. To capture learners' mental models in relation to the solar system, we collected and analysed drawings of the solar system (N=100). After categorising the drawings, we identified specific gestalts. Additionally, we focused on the evolution of these gestalts facilitated by teaching artefacts, and which constructs these models form.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

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Art analysis, the Photoelectric Effect and the Electromagnetic spectrum in a Physics class

Authors: Brenda Ixcuiname Saavedra[1]; Cesar Mora[None]; Mirna Villavicencio[2]

[1] *GIREP 2023*

[2] *UNAM*

This work presents a didactic strategy for High School students, integrating Physics concepts like the electromagnetic spectrum and the photoelectric effect to analyze artworks. Students investigate noninvasive spectroscopic techniques to examine pigment composition and artwork history. Then the students create infographics to communicate their findings, use ultraviolet lamps to reveal hidden details in currency bills, demonstrating the electromagnetic spectrum's applications. Finally, they analyze artworks by Remedios Varo, discussing the properties of electromagnetic waves. These activities foster critical thinking and practical scientific inquiry, enhancing appreciation of both science and art preservation.

How would you like to present your contribution?:

Hybrid from my own country (later in the conference day, best for Americas)

Target education level:

Secondary

Category:

Formal Education

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Approaching astronomy at nursery school: a reflection on teaching practices and student learning

Author: Soria HAMDANI - BENNOUR[None]

Children are interested in astronomy from early age. Numerous studies have been carried out to analyze teacher's and student's representations of astronomy. The first one focused by Piaget was concerning children and their development. Another one was carried out by Sharp in 1995. but no study has yet focused on nursery school pupils. We are therefore proposing an approach to astronomy with pupils aged 4 –5 years to highlight their initial representations and how the activities contribute to the acquisition of scientific knowledge.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Formal Education

Oral presentations / **98**

Student Understanding of Divergence and Curl

Authors: John Thompson[1]; Michael Loverude[2]; Zeynep Topdemir[None]

[1] *University of Maine*

[2] *California State University Fullerton*

As a part of a broader project that aims to investigate students'mathematical understanding in physics, this study explores how students understand the partial derivatives of divergence and curl of vector field diagrams. Student difficulties finding partial derivatives of divergence and curl of vector field diagrams will be reported.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / **103**

Issues in international physics education –1980s

Author: Dean Zollman[None]

Recently, I was able to read through almost all of the Newsletters of the International Commission on Physics Education (ICPE) that were published from 1981 to 1990. As it is now, ICPE in the 1980s was quite active in sponsoring conferences. These Newsletters also frequently contained lead articles. Some of the articles discuss the teaching of physics; others talk about issues related to a global region. Considering the topics covered at the conferences and in the articles in the Newsletters we can see how some issues have changed and others have not during the past 40 years.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Oral presentations / 288

Fighting climate change by doing a practitioner inquiry

Author: Wim Peeters[1]

[1] *PONTOn vzw*

This presentation delves into a practitioner inquiry aimed at enhancing the quality of the 6 CliPs climate change course conducted in April 2023. The inquiry explores the strengths and weaknesses of the course and proposes reshaping it for future iterations while preserving its core objectives. Grounded in a theoretical framework encompassing Inquiry Based Learning (IBL), Practitioner Inquiry (PI), and the STE(A)M cycle, the inquiry utilized various data gathering methods, including surveys, interviews, and reflections. Analysis of the data revealed insights into the course's effectiveness and areas for improvement, providing valuable recommendations for optimizing the learning experience.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Non-formal Education

Oral presentations / 96

Augmented Reality used in physics experiments –Increase pupils interest and reduce the cognitive load?

Author: Hagen Schwanke[None]

Co-authors: Markus Elsholz ; Thomas Trefzger

Corresponding Author: hagen.schwanke@uni-wuerzburg.de

The subject of electricity offers many experiments to use an augmented learning environment. The Application PUMA: Magnetlabor developed in the PUMA project is mainly intended for visualizing the models of the magnetic field and provide an insight into matter. A comparative study examines the influence of augmented reality on cognitive load and situational interest. The focus is pupils' individual perspective. This is assessed by intermediate tests after each of three presentation options. Experiments supported by a simulation application, experiments enriched with an AR application and classical settings are compared.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 287

Affordances of learning engagement using 'MUCBCS' strategy

Author: GRACE DJAN[1]

[1] *GIREP, North West University*

Engagement has been at the forefront of active learning. With the growing capabilities of engagement strategy and its importance for effective learning, the question emerges: how does "MUCBCS" (music, context-based inquiry, computer simulation) contribute to affordances of learning engagement in the science classroom?
It is argued that a strategy fundamental for effective learning and application to physics is to harness the affordances of "MUCBCS". This study investigated the impact of "MUCBCS"on affective and cognitive engagement using semi-structured interviews, pre-tests, and post-tests with 50 science teachers. The results revealed a high Cronbach's alpha value above 0.85 and afforded active participation.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Oral presentations / 251

What criteria should science textbooks meet?

Author: Tereza Fürstová[1]

[1] *Charles University, Faculty of Mathematics and Physics*

This contribution focuses on the search for criteria that should be met by science textbooks. A literature search was conducted and several tools for textbook evaluation or lists of criteria for science textbooks were found. We looked for criteria common to at least three different tools or criteria lists. The criteria found are related to the information in the textbook, its content, the language used, the graphic presentation, and its clarity. These criteria will be used to create questionnaires for students, teachers, and physics teaching experts. Questionnaires will be then used to evaluate a new upper secondary school physics textbook.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 298

When Physics Hurts: how to make learning more memorable

Author: Caleb Clinkingbeard[None]

Attention and personal stake in an issue are the primary determiners of a student's quality of memory encoding and retrieval. Increasing both of those variables is a reasonable choice by educators in their pursuit of better pedagogy. Sometimes physics should hurt.

How would you like to present your contribution?:

Hybrid from my own country (later in the conference day, best for Americas)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 104

The Mentor Learns the Most: The Effects of Curiosity-Driven Discourse on Physics Mentors

Author: Roni Jutkowitz[None]

Co-authors: Avraham Merzel [1]; Yaron Lehavi [2]

[1] *The Hebrew University of Jerusalem*

[2] *The David Yellin Academic College of Education*

Corresponding Author: roni.jutkowits@mail.huji.ac.il

This study explores the transformative impact of curiosity-driven (CD) discourse on teacher-mentors' professional development. Eight physics and mathematics in-service teachers participated in CD discourse workshops, alternating roles as mentors and mentees across four rounds. Leveraging Mason's model, we assess changes in mentors' awareness levels through content analysis by categorizing their responses to open questions. Findings reveal significant shifts in mentors' awareness post-discussion, highlighting heightened generalization abilities. Importantly, CD discourse fosters mutual learning, challenging traditional mentor-centric perceptions and enhancing mentors' teaching practices. Our study underscores the transformative potential of CD discourse, offering insights into its role in shaping teacher professional development.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 38

How do undergraduate students understand the displacement current and apply Ampère-Maxwell's law?

Author: Arturo Marti[None]

Co-authors: Alvaro Suarez [1]; Jenaro Guisasola [2]; Kristina Zuza [3]

[1] *Departamento de Física, Consejo de Formación en Educación, Montevideo, Uruguay*

[2] *School of Dual Engineering, Institute of Machine Tools (IMH), Elgoibar, Spain*

[3] *Department of Applied Physics, University of the Basque Country (UPV-EHU), Spain*

We investigated the learning difficulties of second-year (university) students in electromagnetism courses when applying the Ampère-Maxwell law. We analyzed the written responses of 65 students using phenomenography and supplemented our investigation with 12 interviews. The results revealed that students apply the Ampère-Maxwell law by rote, they believe that it can only be used to calculate magnetic fields when the curve used is symmetrical and they do not consider the shape of the magnetic field lines when applying it.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 228

An advanced form of NetLogo's Forest Fire model: A teaching approach for Primary School students, regarding Complex Systems

Author: Aikaterini Benisi[None]

Co-authors: Vasiliki Psoma ; Ilias Boikos ; Gianna Katsiampoura ; Argyro Toliou ; Constantine Skordoulis ; Alexandra-Triantafyllia Papanagiotou

Corresponding Author: catherineb509@gmail.com

In this paper, a teaching intervention is proposed and described. It is methodologically based on the guided inquiry method, while using the modeling, simulation and programming tool of NetLogo. The pre-existing model "Fire"(from the Models'Library of NetLogo) was modified and additional parameters were added such as speed of wind and its direction and the possibility of low humidity. This approach was implemented in a teaching sequence for Primary School students with the main goal for them to understand the basic concepts that govern the "Complex System"of a forest fire, by interacting with the simulation.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Formal Education

Oral presentations / 13

Methodological skills of in-service physics teachers after a research-based learning course

Author: Esmeralda Campos[1]

[1] *University of Vienna*

Developing research competences is an increasing demand in higher education, as it aims to strengthen the link between research and teaching. The literature has classified research competences into five main dimensions. This study aims to evaluate the dimension of methodological skills acquired by physics education students in a research-based learning course. The participants were 15 in-service physics teachers doing their master's in physics education at the University of Vienna. The results suggest that the students acquired competences to plan research processes and apply noncomplex research methods. These findings can promote the design of research-based courses for physics education students.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 271

Finding connections between physical concepts by playing the game Physics Codenames

Authors: Ladislav Janiga[None]; Viera Haverlikova[1]

[1] *Comenius University in Bratislava, Faculty of mathematics, Physics and Informatics*

Corresponding Author: ladislav.janiga@fmph.uniba.sk

The paper presents an educational game called Physics Codenames, which aims to enhance pupils' comprehension of physics concepts. In the research, we observed the game process within three groups: first-year university students, pre-service teachers of biology, chemistry, and geography, and upper-secondary students. The clues and associated concepts were recorded, along with player discussions. The preliminary results indicate that playing Physics Codenames has the potential to develop a physics conceptual apparatus.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **247**

Towards overcoming students' difficulties in understanding graphs

Author: Mirosława Sajka[1]

Co-authors: Roman ROSIEK [1]; Ana SUŠAC [2]; Željka MILIN ŠIPUŠ [3]

[1] *University of the National Education Commission in Krakow*

[2] *University of Zagreb,Faculty of Electrical Engineering and Computing, Department of Applied Physics*

[3] *University of Zagreb, Faculty of Science, Department of Mathematics*

This study was designed to overcome students' difficulties in interpreting motion graphs and describing motion through graphs. We used tasks involving motion that can be observed in everyday life, such as a modified PISA racing car problem, and designed a short intervention. Eye-tracking technology was used to track participants' visual attention while they completed the tasks and analysed the supporting questions. The results highlight the challenges of responding too quickly and treating graphs as pictures. The findings underline the benefits of even a short intervention that encourages a reflective approach and addresses intuitive reasoning to improve students' understanding motion graphs.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Oral presentations / **65**

A case of four groups of stakeholders: Do we want the same physics curriculum?

Author: Vojtěch Žák[None]

Co-authors: Martin Chvál ; Petr Kolář

This study explores the views of leading physicists, other scientists, physics teachers from upper secondary schools, and physics teacher educators regarding the physics curriculum. We administered a questionnaire based on previous qualitative research. Only in a few cases the evaluations by other groups of respondents were statistically significantly different from those by leading physicists (indices encouragement and modern physics branches). We also did not identify a reasonable difference between teachers who knew they commented on physicists'ideas and those who did not.

Thus, there is a strong consensus among the investigated groups on what the physics curriculum should be.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 224

The Use of Visual Representations for Light and Sound Topics in Science Textbooks: A Cross-Cultural Study

Author: Kübra Özmen[None]

Co-authors: Hatice Elmacı ; Nilüfer Didiş Körhasan

Corresponding Author: kubraozmen2017@gmail.com

This study compared graphical representations in primary school science textbooks in Turkish and English contexts regarding the light and sound concepts in physics.186 visual representations were analyzed across four textbooks using document analysis methodology. The analysis encompassed graphical types (e.g., iconic, schematic), indexing and captioning of representations, quality (dynamic vs. static), and function of visuals. Results revealed differences between Turkish and English science textbooks, indicating variations in the representation of light and sound topics.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Formal Education

Oral presentations / 109

Promoting critical, creative, and caring thinking skills within the context of environmental issues

Authors: Marie Zweifel[None]; Celina Meißner[1]; Farahnaz Sadidi[None]

[1] *TU Dresden*

Corresponding Authors: celmei00@gmail.com, marie.zweifel@tu-dresden.de

The study aims to develop interdisciplinary teaching units focusing on environmental issues like sea level rise and ocean acidification to promote critical, creative, and caring thinking skills among

9th and 10th-grade German students. The development of the teaching units is inspired by the socio-scientific issues (SSI) framework and Lipman's model on thinking. Teaching materials are developed using hypothetical learning trajectories (HLT). The effectiveness of the courses is evaluated by comparing actual learning trajectories with HLTs, as well as analyzing students'answers to pre-post questionnaires, including open-ended questions. The study offers insights into effectively integrating environmental education with promoting thinking skills.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 210

Teaching Electromagnetic Radiation with Cross-Age Peer Tutoring

Author: Marianne Korner[None]

Co-author: Theresa Scherer

This talk reports findings about the teaching method cross-age peer tutoring (CAPT) with regard to high school students'academic achievement in electromagnetic radiation, and their motivation. Within CAPT, elder students (tutors) teach younger ones (tutees). Additionally to previous studies, revealing evidence that CAPT works effectively in specific contexts, the outcomes of tutors and tutees are compared to those of a control group. The results show that the level of knowledge increases significantly, revealing that the effect of CAPT is in comparable order with that of the control group. Additionally, here was a positive effect on the motivation observed.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 53

How experienced faculty change their teaching practices to fit into reformed courses

Author: Andreja Šarlah[None]

Co-authors: Aleš Mohorič ; Gorazd Planinsic [1]

[1] *Faculty of Mathematics and Physics, University of Ljubljana*

Corresponding Author: andreja.sarlah@fmf.uni-lj.si

The University of Ljubljana, Faculty of Mathematics and Physics is reforming its Applied Physics study program following the Investigative Science Learning Environment methodology. The reformed courses are conducted by teachers who did not have previous experience in teaching reformed courses. They were prepared for the task by receiving a short training in ISLE methodology and by continuous professional development practices during the semester. We report what aspects of teaching through the ISLE approach turned out to be most challenging to develop, what factors seemed to affect these difficulties, and what training practices were recognized as most helpful.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 279

Embracing an inquiry stance in physics teacher professional learning

Author: Eilish McLoughlin[None]

Co-authors: James Lovatt [1]; Paul Grimes

[1] *Dublin City University*

Physics teachers often consider what is the influence of their teaching methods and strategies on their student learning, motivations and achievements. However, teachers often report that they lack the ability or time to systematically examine their own professional practice. This study examines teachers embracing an inquiry stance in their own professional learning.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 16

Early Years Physics and Children's Production of Tablet Videos in Preschool

Author: Andreas Redfors[1]

[1] *Kristianstad University*

This presentation is about physics teaching supported by video productions with tablets in Swedish preschools, which were part of a three-year professional development programme on teaching chemistry and physics. Temporal case studies focused on children's and teachers'communication during jointly developed extended teaching sequences with three- to five-year-old children. The children worked in small groups with one teacher. Results indicate that children's video productions by tablets contributed to learning, but with differences indicated for different levels of abstraction. The consequences for future teaching of early years physics are discussed.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Formal Education

Oral presentations / 231

A scheduled teaching intervention for Newton's Disc, programmable with Scratch, for teaching and learning Optics

Author: Aristotelis Gkiolmas[1]

Co-authors: Aikaterini Benisi ; Anthimos Chalkidis ; Ilias Boikos ; Gianna Katsiampoura ; Zografia Papanagiotou ; George Koutromanos ; Artemisia Stoumpa

[1] *Department of Pedagogy and Primary Education, National and Kapodistrian University of Athenc, Greece*

This paper refers to a scheduled teaching intervention, based on Arduino and the Scratch programming environment, for programming the rotation of small Newton discs. The aim is for students in Primary or Secondary school classes, as well as for University students, to explore concepts of Optics and issues related to elements of Physics. In this context, concepts such as colours and persistence of vision are explored. The project has been published on electronic platforms in Greek. The application and the corresponding teaching intervention in school classrooms can contribute to the feedback from students and teachers regarding learning outcomes.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Oral presentations / 198

Intensive and extensive properties as a crosscutting idea: the case of teaching density

Author: Fadeel Joubran[1]

Co-author: Sabreen NAMA-TITI [1]

[1] *Arab Academic College of Education in Israel*

Cross cutting concepts have been introduced formally as a set of items and are meant to bridge disciplinary borders. They can potentially provide students with an organizational framework for connecting knowledge from the various disciplines. Trying to support this direction, we introduce the Intensive and Extensive Properties as an idea that cuts across science disciplines. This study focuses on 7th grade students'preconceptions about density as an intensive concept. 241 students participated into the study. The results showed that 22% realize that density is an intensive quantity and does not depend on the amount of the system

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 235

Critical review of literature resources on the use of Arduino and smartphones in physics education: a first result of the ADELANTE project

Authors: Gaicomo Bozzo[1]; Lucia Gabelli[2]

Co-authors: Giovanni Organtini [3]; Marta Carli [2]; Ornella Pantano [2]; Peppino Antonio Francesco Sapia [1]

[1] *University of Calabria*

[2] *University of Padova*

[3] *Sapienza University of Rome*

Corresponding Author: lucia.gabelli.1@studenti.unipd.it

The Next Generation program of the EU prioritizes digital transition to address educational inequalities. In Italy, the National Recovery and Resilience Plan highlights the importance of embracing the digital revolution. ADELANTE is a research project aimed at enhancing secondary school physics labs with smartphones and Arduino microprocessors. Despite the abundance of resources, the effectiveness of teaching with these technologies remains understudied. A systematized review was conducted to identify validated experiments in physics education literature. The review has revealed a significant gap in educational applications. These findings will guide the project in designing teaching-learning sequences and identifying areas for further research.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 9

Improving socio-scientific reasoning through field-trips

Author: Paul Böning[None]

Corresponding Author: paul.boening@tu-dresden.de

Perspective-taking is considered as a key competency for socio-scientific reasoning. Out-of-school education has multifaceted potentials for science education because of its authenti¬ci¬ty and cross-disciplinary nature. In a comparative study it is examined to what extent and in which way the visit of an out-of-school-education site during a course with socio-scientific issues influences the socio-scientific reasoning of German high-school students. During the course students provided written statements and had semi-structured interviews both of which were qualitatively analyzed. The findings indicate that such a field-trip can foster the ability to perspective-taking.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 37

Physics teachers' professional development: longitudinal training for building coherent curricula across grades

Author: Valentina Bologna[None]

Co-authors: Francesco Longo ; Maria Peressi ; Paolo Sorzio

A relevant part of Physics Education Research is devoted to identifying, searching, and designing processes for implementing professional training development. Among them, the greatest attention focuses on secondary education, somehow in higher and less on primary education. Instead of fragmented scenarios for different grades, we developed a longitudinal training experience engaging Physics teachers from different instruction levels to participate in a huge community of practices. Belonging to this community, teachers reflect and develop new habits of mind and practices when they adopt the ISLE approach in their classrooms. Here, we report the main features and outcomes of the training process.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 226

Analysis of physics textbooks presenting electromagnetic waves at upper secondary level

Authors: Danilo Catena[1]; Ignacio Idoyaga[2]

Co-authors: Lorenzo Santi [1]; Marisa Michelini [1]

[1] *University of Udine*

[2] *University of Buenos Aires*

Corresponding Author: 164019@spes.uniud.it

Electromagnetic waves represents the propagation of the electromagnetic field. In this study we investigate how electromagnetic waves are presented in physics textbooks at upper secondary level. We focused the analysis on the most used textbooks in Italy and Argentina, as in some other countries the electromagnetic waves are not part of school curricula. We elaborated a rubric according to which we carried out the analysis. Its criteria represents the key aspect that we identified from the epistemological reconstruction. Each criterion is evaluated according to a three-tier scale. The analysis is ongoing, and the results will be presented at the conference.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 269

The use of games in physics teaching

Author: Tünde Kozánek Kiss[None]

Co-author: Lívia Sobinovská

Game is a method of active learning, that teachers may use not only to fix already acquired knowledge, but also to convey new information, or as a means of assessment. In this paper we will present our research, which is focused on the use of games in physics teaching and on identifying the factors influencing the use/non-use of games in physics teaching by primary and secondary school teachers in Slovakia. The paper also compares the views of physics teachers from 2010, who were involved in research with the same focus, with the current views of physics teachers.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **62**

Astronomical observations: A non-formal and itinerant approach for Physics and Astronomy teaching

Author: Edio da Costa Junior[None]

Teaching Astronomy is a great challenge, specially in Brazil. On the other hand, astronomical observations can contribute to the dissemination and teaching of Astronomy and Physics, supporting teachers and students. The topic is important and should be instigated both in non-academic scope as well as in the scope of teacher and student training. An itinerant project about Astronomy has been developed since 2011. More than 9,000 people with different levels of scientific knowledge and interest have attended the activities. This work aims to analyze the effectiveness of different non-formal approaches that can be used with a lay audience.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Non-formal Education

Oral presentations / **115**

Science Identity Development in Early Physics and Chemistry Classes: A Longitudinal Study

Author: Frederik Bub[None]

Co-authors: Thorid Rabe ; Lisa-Marie Christ ; Olaf Krey

Corresponding Author: frederik.bub@physik.uni-halle.de

The study takes a comprehensive look at students'educational choices from the perspective of identity. German students are surveyed at three points in time during the initial physics and chemistry lessons. We present the study design and then focus on the quantitative findings. Constructs associated with identity are analysed and corresponding scales are validated. Gender proves to have strong influence on physics- and chemistry-specific constructs surveyed. A decline in constructs such as interest and self-efficacy expectations can be observed during early science classes which will be discussed with regard to students'educational choices.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 283

Cultivating students' reading and communication skills in Physics

Author: Antti Rissanen[1]

Co-authors: Jouko Vankka [1]; Kalle Saastamoinen [1]; Totti Laitinen [1]

[1] *National Defence University*

In science education students learn to utilize discipline-specific mathematical concepts, but, it is equally important to develop students' deeper understanding of physics. Traditional courses with textbooks and basic exercises have their limitations in developing students' understanding and critical thinking. This study presents pedagogical strategies that can foster students' creative thinking and problem-solving skills through concept maps and question strategies. The study examines the tactics developed at NDU to promote deeper learning among students. Useful for learning are interrogative questions and combined models that give students the freedom to ask even less complete questions.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 240

The Relationship Between High School Students' Sense of Belonging to Physics, Physics Identity, and Physics Achievement

Author: Merve Düriye Biçmen Şenol[1]

Co-author: Kübra Özmen

[1] *Doğan Cüceloğlu Science High School*

Corresponding Author: bicmenm@gmail.com

This research explores how the sense of belonging and physics identity are associated with physics achievement in terms of grade level and gender. Five hundred sixty-six students from a science high school participated in the study. Data collection was done via an online survey. Spearman-Rank test was conducted to determine the relationship between these variables. Female high school students

perceive themselves as less competent compared to males. In contrast, male students exhibit less hesitation in identifying themselves as physics persons and show higher scores in physics identity sub-dimensions, aligning with previous research indicating higher levels of belongingness among males.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 158

Developing an Understanding of Inertia through Hands-on Activities: Emphasizing Meaning over Rote Memorization

Author: Beril Yılmaz Senem[None]

This study addresses the impact of hands-on activities on pre-service science teachers identified as low achievers in physics, aiming to not only enhance their understanding of inertia but also cultivate effective teaching practices. Through a case study conducted with 17 pre-service science teachers, data was gathered through lab reports, observations, and a questionnaire. Findings reveal a varied understanding of inertia among participants, with misconceptions prevalent. While participants demonstrated interest and perceived advancements in their comprehension, many expressed a sense of incompleteness in their understanding. Nevertheless, they expressed a willingness to integrate such activities into their teaching practices regarding student engagement.

How would you like to present your contribution?:

Hybrid from my own country (early in the conference day, best for Asia, Australia)

Target education level:

University

Category:

Formal Education

Oral presentations / 229

Flipped classroom: Effects on the conceptional understanding in electric circuit teaching

Author: Wolfgang Lutz[None]

Co-author: Thomas Trefzger [1]

[1] *Universität Würzburg*

Corresponding Author: wolfgang.lutz@uni-wuerzburg.de

On the basis of a design-based research approach, a learning environment suitable for the application of flipped classroom was developed for teaching simple electric circuits. A large-scale assessment was used to evaluate the effects. This learning environment included diverse digital offers and various practical in-class exercises. In addition to the teaching concept, this contribution discusses the effects of flipped classroom on the development of conceptional understanding. It particularly differentiates whether the effects are caused by the underlying didactic concept and the thus created learning materials, by the flipped classroom method, or a combination of the two.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **211**

Challenges of Pre-service Physics Teachers in Implementing Authentic Argument Driven Inquiry (AADI): A Three-Phase Study

Authors: Dilber Demirtaş[None]; Ufuk Yıldırım[None]; Ömer Faruk Özdemir[None]

The researchers designed and implemented Authentic Argument Driven Inquiry (AADI) activities in an undergraduate elective course to reveal challenges faced by pre-service physics teachers (PPTs) in AADI activities. The course was structured into three phases: learning, preparation, and teaching. This study specifically focused on three PPTs with the lowest performance, out of ten taking the course. Data sources included video recordings of the class sessions and interviews with the participants, materials of the course, and reflection papers. Data analysis revealed that challenges differed for each PPT across phases and activities due to the content-dependent nature of the relevant skills involved.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / **71**

Investigating the Role of Mathematics for Learning Quantum Physics

Author: Moritz Förster[1]

[1] *TU Dresden*

Corresponding Author: moritz.foerster@tu-dresden.de

Quantum physics is inherently described by mathematical structures. Hence, it seems plausible that mathematical knowledge might support its conceptual understanding already in upper-level secondary school. It is therefore desirable to develop and evaluate corresponding teaching-learning sequences. However, for a successful implementation, it is crucial that teachers accept and understand such sequences. In a first step, by an explorative interview study we investigate in-service teachers'and prospective teachers'acceptance and understanding of a mathematical description of fundamental principles of quantum physics. We present the analysis of the interview data with respect to attitudes about the teaching-learning sequence and difficulties in understanding.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 129

The role of uncertainty in developing sustainable futures scenarios

Author: Lorenzo Miani[None]

Co-authors: Francesco De Zuani Cassina ; Olivia Levrini [1]

[1] *Department of Physics and Astronomy, University of Bologna*

This contribution explores the integration of uncertainty as a pedagogical tool in a climate change course designed for 12th-13th grade students. Drawing on interdisciplinary perspectives from physics education and futures studies, the course utilises an original board game to foster students'awareness of climate complexities and support sustainability competences development. The board game incorporates three kinds of uncertainties and leverages a simulator to explore climate-related decision-making, to stimulate students' critical reasoning while creating future scenarios. Findings suggest that the game effectively enhances students' comprehension of climate phenomena and decision-making processes, albeit with varied emotional responses, ranging from curiosity to hopelessness.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 265

Knowledge and evidence over fear of invisible radiation via practically oriented teaching with a particle camera instrument

Authors: Michael Holik[1]; Stanislav Pospisil[2]; Vladimir Vicha[3]

[1] *IEAP CTU in Prague, FEE UWB in Pilsen*

[2] *Institute of Experimental and Applied Physics, Czech Technical University in Prague*

[3] *IEAP CTU in Prague*

The invisible ionizing radiation often evokes fears in people's minds as there is no easy way to show and evaluate real impact on their existence. The educational kit SESTRA (School Educational Set with Timepix for Radiation Analysis) has been developed at IEAP CTU in Prague with intention to allow easy access to microcosmos experiments, to anyone, practicable in regular classes. The contribution presents the potential of practically oriented teaching and experience gained with students at various levels of education when they get exposed to clear evidence on properties of various radiation types and presence in the surrounding environment.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Non-formal Education

Oral presentations / 93

A scheme to support preservice physics teacher in analysing curriculum materials

Author: Markus Obczovsky[None]

Co-authors: Claudia Haagen-Schützenhöfer ; Thomas Schubatzky

Though curriculum materials (CMs) are an important source for teachers'when designing classroom instruction, the dissemination of innovative CMs has limited influence on teacher practice. A common explanation for this phenomenon is that teacher interpret CMs different than developers. Thus, some teacher educators argue that preservice teachers need to learn how to interpret CMs in order to make meaningful instructional decisions and subsequently design meaningful classroom instruction. We iteratively developed a research-based scheme to support preservice physics teachers in analysing innovative CMs. In a presentation, we will present the scheme, its research-driven development and discuss its potential for teacher education.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **255**

Weather Literacy: Assessing Third-Grade Students' Knowledge and Skills related to weather

Author: Kristel Uiboupin[None]

Co-authors: Krista Uibu ; Piia Post

Weather literacy is highly important and closely intertwined with everyday life. Our knowledge regarding the weather comprehension of third-graders and their ability to interpret weather patterns still needs to be improved. The findings of this study revealed that students better understand precipitation and temperature yet need to show greater comprehension of cloud cover and wind patterns. Furthermore, interpreting combinations of weather elements and phenomena proved more challenging. The implications of these findings prompt considerations on how weather literacy is cultivated within school curricula, strategies for managing hazardous weather situations, assessing the weather's impact on students to mitigate potential risks.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Formal Education

Oral presentations / **232**

Imaginative Embodied Forms of Expression in Macroscopic Physics for K-6 Teacher Education

Authors: Federico Corni[1]; Hans U Fuchs[1]

[1] *Faculty of Education, Free University of Bozen-Bolzano, Bressanone, Italy*

When we directly (physically) encounter Forces of Nature such as Wind, Light, Heat, or Water, the embodied gestalt of a powerful entity forms in our mind. This gestalt is characterized schematically and elaborated metaphorically and analogically, which allows for the construction of imaginative forms of communication supporting concept formation. Examples of forms of expression include natural language stories, bodily mimesis, art, and mathematics. Here, we discuss the use of bodily mimesis in the form of Forces-of-Nature Theater performances, and stress the importance of integrating mimetic expression with other forms of communication (i.e., using polysemiosis) for substantial learning to occur.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 206

The Training Needs of Physics Teachers: a Challenge from the Association for Physics Teaching

Author: Vera Montalbano[1]

[1] *University of Siena*

Corresponding Author: montalbano@unisi.it

A comparison is presented between the training needs expressed by a significant number of physics teachers (about a thousand) and the perception of the effectiveness of the various Association for Physics Teaching (Associazione per l'Insegnamento della Fisica, AIF) in-service training initiatives on AIF's members. The analysis presents ideas on which initiatives are most effective and how to propose training activities that satisfy the real training needs of in-service teachers. The AIF's commitment to promoting innovative and effective teaching methods in the most diverse contexts favoured discussion in the conference between different stakeholders interested in a widespread improvement in physics teaching.

How would you like to present your contribution?:

Hybrid from my own country (early in the conference day, best for Asia, Australia)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 155

Investigating students' insight after attending an optimized research-based planetarium presentation about the apparent motion of the Sun and stars

Authors: Hans Bekaert[1]; Hans Van Winckel[1]; Mieke De Cock[None]; Wim Van Dooren[1]

[1] *KU Leuven*

We investigated the extent to which attending a planetarium presentation increases secondary school students'understanding of the apparent motion of the Sun and stars. We developed a new planetarium presentation with particular attention to the use of the celestial sphere model and a learning module that prepares students at school for this presentation. We measured the learning gains among 16-17 years old students using the AMoSS test. We find that the learning gains for the star questions are significantly higher than what we found in earlier studies. This is due to better scores on questions about the yearly apparent motion.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 278

Greek Science Teachers' Views about the Use of Educational Simulations in their Practice

Author: Crysanthi Gidari-Gounaridou[1]

Co-author: Ioannis Lefkos [1]

[1] *Laboratory of informatics and Robotics in Education and Society, University of Macedonia*

Corresponding Author: lefkos@uom.edu.gr

Simulations are one of the most powerful digital tools for science education. This paper investigates the views of Greek secondary school teachers regarding the use of simulations in the teaching and learning of science, aiming to probe the individual factors, positive or negative, that may influence their decisions regarding integrating simulations into their practice. Our preliminary results show that despite the poor technical infrastructure reported by most respondents, teachers display a positive view concerning the use of simulations in science education due to their perceived value in learning. A few teachers display negative views when comparing simulations with traditional laboratories.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 264

Physics for non-physicists - A scientific propaedeutic for prospective medical students

Author: Lars-Jochen Thoms[1]

Co-authors: Christoph Hammer [2]; Florian Bernhard [3]; Julia Karmann [4]; Mihály Hömöstrei ; Thomas Frank [5]

[1] *University of Konstanz*

[2] *Institute of Mathematics, Osnabrück University, Albrechtstr. 28a, 49076 Osnabrück, Germany*

[3] *Ammersee-Gymnasium, Dießener Str. 100, 86911 Dießen am Ammersee, Germany*

[4] *Gymnasium Donauwörth, Pyrkstockstraße 1, 86609 Donauwörth , Germany*

[5] *Otto-von-Taube-Gymnasium, Germeringer Straße 41, 82131 Gauting, Germany*

Corresponding Author: lars.thoms@uni-konstanz.de

We present a propaedeutic program aimed at prospective medical students, focusing on enhancing their understanding of physics and natural sciences. Recognizing the importance of these fields in medical studies and the challenges students face in achieving high grades in natural sciences, the program offers hands-on experimentation and research opportunities. Initiated by the German Student Scholarship and the Else Kröner Fellowship, it targets disadvantaged youth aspiring to study medicine. The program, evaluated over two cohorts, demonstrates significant success and acceptance among participants, underscoring the necessity of scientific foundational knowledge for a successful medical career.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Non-formal Education

Oral presentations / 24

Students'Interest in Physics –Study Results from Georgia

Author: Marika Kapanadze[1]

Co-authors: Natela Bagatrishvili [2]; Lia Dzagania [1]; Nino Javakhishvili [1]

[1] *Ilia State University*

[2] *Iakob Gogebashvili Telavi State University*

Corresponding Author: marika_kapanadze@iliauni.edu.ge

Students'interest in physics is currently an important issue for effective learning and teaching in many countries. We report about the results of an extensive physics students'survey at the end of compulsory education and the beginning of upper secondary school in Georgia. Students'interest in physics is investigated in different contexts regarding 'out of school'experiences, attitudes toward environmental issues, and science and technology. Comparison of the two study results will be presented. Some recommendations for the development of physics curricula, textbooks and teacher education programs in the country are elaborated.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Workshop / **299**

Catch the Balance: DIY toys for inquiry physics

Author: Mirela Kaczmarek[1]

[1] *University of Wrocław*

During the workshop, participants will make their own physics toys to help build intuition related to learning physics, especially about mechanics and center of mass. They will also discover practical ways to use such toys at different stages of education to build engagement and interest in science subjects. Simple toys made from accessible materials are a pretext for teaching through inquiry.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Workshop / **15**

Engaging Students in Class and Virtually with Interactive Lecture Demonstrations (ILDs)

Author: David Sokoloff[None]

Abstract. The results of physics education research and the availability of computer-based tools have led to the development of research validated active learning strategies that have been demonstrated to enhance learning in the introductory physics course. One reason for the success of these materials is that they engage students to take an active role in their learning. This workshop will demonstrate Interactive Lecture Demonstrations (ILDs) through active participation. The workshop will include work with a virtual version—Home-Adapted ILDs—to be used in distance learning situations. ILDs have been demonstrated to substantially improve conceptual learning.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Workshop / **108**

Using MACROBITS to illustrate the logic of quantum cryptography protocols

Author: Joao Pereira[1]

[1] *UNIRIO*

Abstract. Quantum information requires a different way of thinking and sets a challenge to science education. One amazing characteristic of quantum algorithms is to deliver results with 100% certainty despite the probabilistic nature of quantum mechanics in which they are based on. In the proposed workshop, two educational routines based on quantum cryptography protocols (BB84 and Ek91) are presented as a hands-on activity. The procedures use tokens called MACROBITS and are designed so the logic involved in quantum key distribution can be grasped by the audience. The workshop aims to perform a transmission of a short message between two participants.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Workshop / 113

Thinking-Back-and-Forth in Practical Work

Author: Wouter Spaan[None]

Corresponding Author: w.p.spaan@hva.nl

During practical work students are typically more concerned with hands-on aspects, than with underlying minds-on aspects. Hence, it is hard to reach any minds-on learning goals, leading to relatively ineffective lesson time. In this workshop the framework of Thinking-Back-and-Forth (TBF) between hands-on and minds-on is presented and it is used to analyse existing practical work about possibilities to connect hands-on to minds-on. The framework has been developed to enable teachers to critically reflect on and improve their current practice regarding practical work in small, tangible steps. It has proven to be a valuable addition to pre- and in-service teacher education.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Workshop / 245

School-University Collaboration and Teachers' Professional Development

Authors: Claudio Fazio[1]; Emilio Mariotti[2]; Francesca Telesio[3]; Giorgio Pastore[4]; Giovanni Organtini[5]; Ilaria De Angelis[None]; Joan BORG MARKS[6]; Lorenzo Santi[None]; Marco Giliberti[7]; Maria Bondani[8]; Maria Peressi[None]; Marilu Chiofalo[None]; Marina Carpineti[9]; Marisa Michelini[None]; Marta Carli[None]; Massimiliano Malgieri[None]; Matteo Tuveri[None]; Maura Pavesi[10]; Olivia Levrini[11]; Stefania Pagliara[12]; Valentina Bologna[None]; Vera Montalbano[13]

[1] *Università degli Studi di Palermo*

[2] *Department of Physical Sciences, Earth and Environment, University of Siena, Siena, Italy*

[3] *University of Genova*

[4] *University of Trieste*

[5] *Sapienza University of Rome*

[6] *University of Malta*

[7] *University of Milan*

[8] *CNR - Institute for Photonics and Nanotechnologies*

[9] *Dipartimento di Fisica - Università degli Studi di Milano*

[10] *University of Parma*

[11] *University of Bolognia*

[12] *University of Brescia*

[13] *University of Siena*

This Workshop (WS) aims at sharing a history of collaborative research between schools and universities developed within the Italian PER community, discussing where we are and identifying future perspectives. The WS outcomes will inform a position paper.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Symposium / 39

Physics Education: Approaches from ICPE-IUPAP C14 Community

Author: Jenaro Guisasola[None]

Co-authors: Angela Fösel [1]; Eilish MCLOUGHLIN [2]; Elizabeth Angstmann ; Manjula D. SHARMA [3]; Tetyana ANTIMIROVA [4]

[1] *(2) Physics Department. Friedrich-Alexander-University of Erlangen-Nürnberg. Germany*

[2] *(3) School of Physical Sciences & CASTel. Dublin City University. Ireland*

[3] *School of Physics, University of Sydney, NSW, Australia, 2006*

[4] *Department of Physics. Toronto Metropolitan University, Canada*

The physics outreach and teaching activities undertaken by members of the International Commission of Physics Education (ICPE- IUPAP C14) involve a wide range of perspectives, populations and methods. A unifying theme is that the problems investigated by ICPE arise from the teaching and learning of physics, including its concepts, principles, epistemology and culture. In this Symposium, the activities of physics teacher education and the dissemination of effective approaches to teaching physics provide a context for illustrating the kind of activities ICPE engages in.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Symposium / 179

Physics Education in the Digital World

Authors: Anna Lager[1]; Lena von Kotzebue[2]; Marilena Streit-Bianchi[3]

Co-authors: Alexander Finger [4]; Christoph Thyssen [5]; Erik Kremser [6]; Jari Lavonen [1]; Johannes Huwer [7]; Lars-Jochen Thoms [7]; Marina Connell ; Matteo Tuveri ; Monique Meier [8]; Sebastian Becker-Genschow [9]; Till Bruckermann [10]

[1] *University of Helsinki*

[2] *University of Salzburg*

[3] *CERN*

[4] *University of Leipzig*

[5] *University of Kaiserslautern*

[6] *Technical University of Darmstadt*

[7] *University of Konstanz*

[8] *Technical University of Dresden*

[9] *University of Cologne*

[10] *University of Hannover*

Corresponding Authors: andreas.mueller@unige.ch, matteo.tuveri@ca.infn.it, lars.thoms@uni-konstanz.de

Distance teaching, notably during the recent pandemic, has highlighted challenges in physics and STEM education globally. Efforts are underway to integrate computer-assisted data acquisition, mobile devices, and AI to enhance classroom learning. However, the effective use of digital technologies depends on developing teacher competencies, promoting digital literacy among students, and implementing active learning strategies that incorporate modern physics. This symposium aims to explore sustainable physics education through classroom interventions and teacher development, focusing on integrating modern physics and digital tools with current educational programs.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Symposium / 154

Mathematical Reasoning in University Physics

Authors: Any Urrutia[None]; Charlotte Zimmerman[None]; Maria Al Dehaybes[None]; Mieke De Cock[1]; Orlaith Condon[2]; Paul van Kampen[None]

[1] *KU Leuven*

[2] *Dublin City University*

Physics and mathematics are deeply connected. However, there is ample research that mathematical reasoning in physics is not at all trivial for students. We present four contributions that discuss different aspects of mathematics and mathematical representations in university physics. The first contribution discusses student understanding of the Laplacian in the heat equation. In the second contribution, we report on students'interpretation of graphs representing non-constant acceleration motions. Study three deals with students'reasoning processes while constructing graphs. The last contribution reports on the translation and administration across different institutions in Europe and the U.S. of two instruments measuring quantitative reasoning.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 121

Design and trialling of an educational sequence on surface phenomena for university students

Author: Ilaria Grazia[None]

Co-authors: Onofrio Rosario Battaglia ; Giulia Termini ; Claudio Fazio [1]

[1] *Università degli Studi di Palermo*

Corresponding Author: ilaria.grazia@unipa.it

In this work we present the design and trialling of a teaching-learning sequence (TLS) for university students on surface phenomena. The TLS is aimed at favouring in the student a gradual process of active construction of knowledge. The theoretical framework chosen for the TLS combines concepts from psychology, physics education research, and epistemology. Students use inquiry-based methodologies to identify hypotheses, practice the use of critical thinking, and consider alternative explanations for the interpretation of proposed physical situations. The aim is to combine the scientific and students'perspectives to maximize learning.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 94

The influence of using TikTok as a learning tool on grade 8 learners' understanding of static electricity

Authors: Jeanne Kriek[1]; Mari-Louise Van der Merwe[2]

[1] *University of South Africa*

[2] *Conference attendee*

TikTok videos were used in an exploratory study with grade 8 learners (n= 59) randomly assigned into three classes: Experimental Groups (EG1; EG2), and Control Group (CG). Content creators developed the TikTok videos which included real-life examples. In the lessons, the learners in the experimental groups watched seven teacher curated TikTok videos on concepts in static electricity. Findings indicate that EG2 learners had a significant statistical difference (p = 0.03471) in performance compared to EG1 and CG. From Hake's average gain a moderate positive gain was found for EG1 and EG2, which is in significant contrast to the CG.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 26

Physics of the Earth in introductory geosciences: an exploration of interdisciplinarity

Author: Kirsty Dunnett[None]

Co-author: A. Mattias Lundmark

Topics from physics occur frequently in the geosciences and are among those reported to cause students most difficulty. One topic that uses physics in a Earth setting is isostasy that accounts for many Earth features as the interplay of elasticity and buoyancy of the Earth's outer mechanical layer (the lithosphere). We explore the presentation of isostasy in introductory undergraduate geosciences textbooks and use a framework for interdisciplinary reasoning and communication to analyse the demands made on students. Presentations are highly variable and often complex; the buoyancy-only model is emphasised and a prior knowledge of hydrostatics typically assumed.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 106

STEM researchers' practices for public trust enhancement

Author: Athanasia Kokolaki [1]

Co-authors: Eleni Botzaki [1]; Emily Michailidi [1]; Dimitris Stavrou [1]

[1] *University of Crete*

The present study explores the practices employed by STEM researchers when communicating current scientific issues to the general public in order to enhance public trust in science. The study took place in the context of the European project "STAGE". Ten STEM researchers, four STEM education researchers and four science communicators participated in the research. The preliminary results indicate that the predominant practices employed by STEM researchers to enrich their current science communication activities for fostering public trust in science include the use of interactive materials, the integration of authentic scientific practices and the negotiation of the social aspects of science.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Informal Education

Oral presentations / 128

Teaching vignettes for working with Arduino in science teacher education

Author: Angelika Bernsteiner[1]

Co-authors: Claudia Haagen-Schützenhöfer ; Philipp Spitzer [1]; Thomas Schubatzky

[1] *University of Graz*

We developed and researched a course focusing on preparing teacher students for working with Arduino. Based on theoretical foundations and empirical findings, teaching vignettes for reflecting on teaching and learning with Arduino were implemented into the course. The course design was implemented with 13 mathematics and science secondary teacher students in the winter semester of 2022/23. A mixed-methods approach was employed to investigate learning processes of the teacher students. The results show that the course design incorporating teaching vignettes offers teacher students opportunities to experience and reflect teaching and learning with Arduino from both a learner's and a teacher's perspective.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 194

The addition of an interdisciplinary approach for holistic learning

Author: Lucija Mihelak[1]

[1] *Gimnazija, Solski center Velenje, Slovenia*

Teaching today is undergoing many changes. Education according to the STE(A)M principle and interdisciplinary approaches contribute to the fact that pupils' knowledge and competences are comprehensive and useful, as this allows students to acquire knowledge more independently and connect different fields. But if we work in class according to such concept, the amount of processed material would consequently be smaller. To avoid this, we want to do both in a way. I'll present how students can use knowledge from the regular curriculum by participating in projects and elective courses operating on the principle of STE(A)M, while developing this knowledge holistically.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 105

What is so difficult in quantum physics? Diagnosing high school students' difficulties in quantum physics

Authors: Alexandra Goltzman[1]; Avraham Merzel[2]; Efraim Yehuda Weissman[3]

[1] *The Seymour Fox School of Education The Hebrew University of Jerusalem, 9190501, Jerusalem, Israel*

[2] *The Hebrew University of Jerusalem*

[3] *Jerusalem College of Technology*

High school students learning quantum physics (QP) exhibit difficulties. In this Study, we investigate in-lesson interactions in the classroom, aiming at identifying these difficulties and their origin. Through the lens of combined categorization system from the literature, we used content and interaction analysis of videotaped lessons. We found difficulties in unexplored topics in QP education, and found that some of them originate in teacher-student interactions, while others result from previous teaching. Our results enrich teachers' pedagogical content knowledge for high school QP. They could be used for the design of learning materials and foster the creation of diagnostic tools.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **277**

The Rasch model in the role of assessing the characteristics of the group of students on the physics knowledge test

Author: Ivana Štibi[None]

Co-authors: Jerneja Pavlin ; Mojca Čepič [1]

[1] *University of Ljubljana, Faculty of Education*

Corresponding Author: istibi@fizika.unios.hr

PER must be based on effective measurement techniques. One approach to addressing the need for careful measurement is Rasch analysis which facilitates the development of a measuring. In this contribution, we will present the results of the longitudinal study of applied physics knowledge tests conducted three consecutive years during different teaching conditions in Croatia at the level of the first, second and third grades of high school with the four-year Physics program. Rasch analysis has been used in parallel with CTT, which gives an insight into the characteristics of the test (both items/questions and students who took the test).

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Oral presentations / **309**

Nuclear astrophysics masterclasses as an interest-promoting learning environment

Author: Daniel Bemmerer[None]

Co-authors: Hannes Nitsche [1]; Lana Ivanjek ; Uta Bilow [2]

[1] *Technische Universität Dresden*

[2] *Technische Universitaet Dresden (DE)*

Corresponding Authors: lana.ivanjek@jku.at, hannes.nitsche@tu-dresden.de, uta.bilow@tu-dresden.de, d.bemmerer@hzdr.de

Masterclasses are one-day outreach events for high school students, introducing them to topics of current research. Within the ChETEC-INFRA project, Masterclasses on Nuclear Astrophysics were developed. This interdisciplinary field of science provides a new didactic perspective on nuclear physics and astrophysics by addressing the link between these subjects. The Masterclasses pick up this didactic potential. They include the reconstruction of processes behind the nucleosynthesis with the help of gamification elements and the analysis of scientific data. The masterclasses are evaluated with questionnaires in a pre- and post-design to investigate the potential of promoting interest in the subject of nuclear astrophysics.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Non-formal Education

Oral presentations / 324

STEM Education: A Remote Laboratory Implementation in Physics Courses

Authors: Benny Lovstrom[1]; Lena Claesson[2]

[1] *Blekinge Institute of Technology, Karlskrona*

[2] *Katedralskolan, Lund, Sweden*

Corresponding Author: lena.claesson@lund.se

In 2020, due to the pandemic and lockdowns, upper secondary schools and universities worldwide rapidly transitioned classes and activities to be conducted remotely. This transition presented particular challenges for laboratory courses in science education. The study presented here was carried out in a higher education institution and an upper secondary school in Sweden in three different courses where a remote laboratory VISIR addressing electric and electronic topics was implemented. The data collected from 254 students'activities and teachers'experiences of the factors affecting the usage of the VISIR during implementation are presented.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 68

A New Sequence Model of Interdisciplinary STEM Learning: From Theory to Practice

Author: MARINA CONNELL[1]

[1] *Former University Professor & Teacher, EdTech STEM Strategist in Asian Development Bank funded project, Managing Director at Marina and John Connell Education Ltd., Edinburgh, Scotland, UK*

The presentation explores the concept of A New Sequence Model of Interdisciplinary STEM Learning (NSMISL) that does not require any radical initial change to a country's established curriculum. NSMISL aims to integrate the four core disciplines of science, technology, engineering, and mathematics, as well as subjects such as geography, economics, physics, chemistry, and art, through Collective Planning, Project-based Learning and Inquiry based learning. NSMISL also emphasises the importance of teaching and learning Physics and Artificial Intelligence, especially in relation to the emergence of Large Language Models.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Oral presentations / 64

Interplay between identity and agency in the context of physics education in Turkey: Case study.

Author: Özden Şengül[1]

[1] *Boğaziçi University*

Abstract. This study investigates the interaction between identity and agency of physics teachers in Turkey from a sociocultural perspective. Data collection included individual semi-structured interviews, fieldnotes from classroom observations, informal interviews after observations, and lesson artifacts. Data analysis of the qualitative data was through thematic analysis to identify and code for recurring themes that illustrate the participants'views and practices. The results indicated the differences in two teachers'agency in terms of their beliefs, practices and social interaction with their colleagues and students. The study has implications for the preparation of pre-service and in-service physics teachers.

How would you like to present your contribution?:

Hybrid from my own country (later in the conference day, best for Americas)

Target education level:

General

Category:

Formal Education

Oral presentations / 10

Differential Impact of Science Instruction on Paranormal Beliefs Among College Students: A Three-Semester Investigation

Author: Mo Basir[None]

This study explores the impact of epistemic-focused science instruction on college students' paranormal beliefs and physics understanding. Despite lacking scientific validation, paranormal beliefs persist. The intervention, extending over three semesters, included epistemic and ontological training to counteract intuitive biases and encourage empirical evidence-based hypothesis formation. Results indicated a slight decrease in paranormal beliefs and a notable enhancement in physics comprehension. K-means clustering showed diverse student reactions to the intervention, while qualitative analyses identified misconceptions reinforcing paranormal beliefs, underscoring the importance of scientific epistemology in reshaping student perspectives.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 162

Different spins on the two-state paramagnet: Pedagogical advantages and considerations

Author: Ebba Koerfer[None]

Co-author: Bor Gregorcic

The two-state paramagnet has previously been proposed as a valuable pedagogical tool for teaching statistical mechanics. In this study, we focused on the role that the two-state paramagnet example played in student discussions while solving problems in statistical mechanics. Students' use of the example was both advantageous and challenging. While we saw students using the two-state paramagnet example to reason analogically about similar systems, we also saw a general lack of in-depth reflection of what makes the model transferable to other contexts. We suggest some considerations for teachers to better leverage this example and facilitate student learning in statistical mechanics.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 178

Visualising the Invisible: Reviewing the Literature on Demonstration Material for Quantum Entanglement

Author: Bart Folkers[1]

Co-authors: Alexander Brinkman [1]; Kirsten Stadermann [1]

[1] *University of Twente*

We present an overview of publications on demonstration material for quantum entanglement. Our study analysed over 80 publications, covering experiments and demonstration materials (DM) for quantum entanglement from 2000 to the present. We provide insights into studies regarding design choices and considerations of different types of DM, differences in the use of mathematics, the role of technologies or possible applications within DM, and conclusions about the impact of DM on students. Understanding choices and considerations made in previous studies can contribute to the development of demonstration materials for quantum entanglement.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 150

Preliminary Investigation of Validating Chain Computer Adaptive Testing Based on the Force Concept Inventory

Author: Haruko Uematsu[None]

Co-authors: Jun-ichiro Yasuda ; Kentaro Kojima ; Michael M. Hull ; Naohiro Mae ; Taku Nakamura

This study explores the feasibility of Chain-CAT, a Computer Adaptive Testing (CAT) approach integrated into the pre-post assessment paradigm in educational contexts. We propose increasing CAT frequency while shortening per-test duration and reducing the total number of items. Utilizing collateral information in CAT algorithms, specifically Bayesian-based proficiency estimation, facilitates efficient testing. A preliminary investigation involving FCI-CAT implementation and interviews suggests potential for Chain-CAT to accurately measure Newtonian mechanical thinking and aid in assessing conceptual understanding progression.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 146

Strengthening of scientific skills from the STEM approach in fifth grade

Author: Kilian Ferney Virguez Lamprea[1]

Co-authors: Adriana Janneth Acevedo Andrade [1]; Diego Fernando Becerra Rodriguez [2]

[1] *Universidad de La Sabana*

[2] *La Sabana University*

This article shows the results of a Challenge-Based Learning (CBL) strategy articulated with the STEM approach. It was developed with fifth-grade students from an educational institution in Chía-Colombia, carried out in four phases: observation, application, characterization, and evaluation, from a qualitative approach. The results show that 22% of the students were at a "no category" level in STEM skills. The processes of observation, questioning, and hypothesizing were also strengthened. Additionally, an institutional characterization of the STEM approach was performed, demonstrating that the institution scored 2.3 on this approach.

How would you like to present your contribution?:

Hybrid from my own country (later in the conference day, best for Americas)

Target education level:

University

Category:

Formal Education

Oral presentations / 317

Inverse Problems and Nonlinear Optimization for Inquiry-based STEM Education Using Open Data Science Tools

Authors: Dominik Borovský[1]; Jozef Hanč[2]; Martina Hancova[3]

[1] *Pavol Jozef Šafárik University in Košice*

[2] *P. J. Safarik University*

[3] *P.J. Safarik University in Kosice, Slovakia*

Corresponding Author: dominik.borovsky@student.upjs.sk

Integrating inverse problems and nonlinear optimization using open data science tools in inquiry-based STEM education presents a significant opportunity to bridge theoretical STEM knowledge with real-world applications. Our contribution highlights the limitations of traditional linear least squares (LS) fitting methods and demonstrates using SageMath for real-world, nonlinear problems, such as the fall of a lightweight polystyrene ball, demonstrating a closer alignment of students' work with scientific computing in actual research. This approach not only enhances STEM education by including a wider range of attractive real-world problems but also fosters modeling and problem-solving skills, crucial for future professional careers.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 148

Communicating Uncertainty in a Planetarium

Author: Jan Sermeus[None]

Co-authors: Jakub Stepanovic [1]; Sandy Claes [2]

[1] *KU Leuven*

[2] *KU Leuven & LUCA*

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Missing and sparse data and the associated uncertainty are inevitable in science, and their accurate portrayal is essential for upholding scientific transparency and credibility. Yet revealing uncertainty can be seen as unfavourable in science outreach. Our study, theoretically initiated in Nature of Science, focused on conveying incomplete data on Venus's upper atmosphere to an adolescent audience in a planetarium. Through design-based research, we found that translating data into a Voronoi diagram can make the concept of sparse data understandable and aesthetically pleasing to a broader audience. However, it may come at the cost of lower perceived accuracy.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Non-formal Education

Oral presentations / 43

Virtual reality in astronomy education: reflecting on design principles through a dialogue between researchers and practitioners

Author: Jackie Bondell[1]

Co-authors: Magdalena Kersting ; Mark Myers [1]; Rolf Steier [2]

[1] *Swinburne University of Technology*

[2] *Oslo Metropolitan University*

This study examines the use of virtual reality (VR) in astronomy education from the joint perspective of educational researchers and education and public outreach (EPO) professionals. Drawing on data from focus group interviews with EPO professionals and scientists from the Australian Research Council Centre of Excellence for Gravitational Wave Discovery (OzGrav), we identify and reflect on

design principles focused on immersion, visualisation, facilitation, and collaboration. We argue that these principles can guide astronomy educators in implementing VR in various learning environments while also contributing to our understanding of how to leverage VR technology in astronomy education successfully.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Informal Education

Oral presentations / 258

Supporting Conceptual Understanding of the Electric Potential and the Electric Field using Virtual Reality

Authors: Roman Schmid[None]; Andreas Vaterlaus[None]; Andreas Lichtenberger[None]

Corresponding Author: roschmid@phys.ethz.ch

Virtual Reality (VR) is a promising technology for enhancing concept learning in physics. We developed a three-dimensional VR learning environment comprising tasks on electric potentials and fields. In an experimental study with 210 students of the advanced track of the Swiss secondary school, we compared the learning gains when students solved the tasks using the VR environment with a VR headset or with a computer or in a non-VR setting using projections printed on paper. While there was no significant difference between the conditions overall, students with lower spatial abilities showed significantly greater learning gains in the VR headset condition.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 102

'Seeing quantum' in a water droplet: On the theoretical development of an experimentally-backed educational analogy

Author: Sebastian Kilde Löfgren[1]

Co-authors: Dag Hanstorp [1]; Javier Tello Marmolejo [1]

[1] *Department of Physics, University of Gothenburg*

Corresponding Author: javier.marmolejo@physics.gu.se

Modeling the hydrogen atom is often considered an essential milestone in an introductory quantum mechanics course. Mathematically, the path is clear: from the square potential well, through the harmonic potential, and culminating with the hydrogen atom. However, a working conceptual path is lacking. Here, we present results from a real experiment where the light scattering of an evaporating, optically levitating water droplet can be explained with a quantum analogy, serving as an 'optical atom.' We have distilled two important concepts in this analogy, angular momentum and tunneling, to explain properties of the hydrogen atom conceptually in an undergraduate teaching context.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 145

Investigating the Beliefs of Experts and of Teachers on Teaching Quantum Physics at Secondary Schools

Author: Marco Di Mauro[1]

Co-authors: Luca Silvio Perli [1]; Pasquale Onorato [1]; Stefano Oss [1]; Massimiliano Malgieri ; Denis Cogo [2]

[1] *University of Trento*

[2] *University of Padova*

Corresponding Author: marco.dimauro@unitn.it

In this contribution, the results of a series of questionnaires conducted both with expert researchers and active high school teachers of physics, concerning aspects of the teaching of quantum physics at the secondary school level, are reported and compared. The addressed issues were the overall appropriateness of this teaching, the (quasi-)historical approach, the necessary mathematical tools and the specific topics that should be included. Some foundational and controversial aspects of quantum physics, which concern potentially includable topics, were addressed as well.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 222

Comparing prior knowledge of first-semester physics students between the cohorts of 2013 and 2023

Author: Dennys Gahrmann[1]

Co-authors: Andreas Borowski [1]; Irene Neumann [2]

[1] *Physics Education, Institute of Physics and Astronomy, University of Potsdam, Potsdam, Germany*

[2] *Leibniz Institute for Science and Mathematics Education (IPN), Kiel, Germany*

Corresponding Author: dennys.gahrmann@uni-potsdam.de

University instructors often recognize lacking prior knowledge in incoming first-semester physics students. In this study, we refined the 1978 national study entrance test (SET, [1]) to assess the physics dispositions of first-semester students and compared two cohorts of first-semester physics students: 2013 and 2023. Our findings reveal a small improvement in physics dispositions (i.e. prior knowledge) nationwide between the cohorts of 2013 (N=2251) and 2023 (N=2007). In 2023 students performed better on items focusing on physics literacy compared to more traditional items focusing on declarative knowledge of facts or standard calculation routines.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 181

The digital repository for physics and science teaching

Author: Ivana Poljančić Beljan[1]

Co-authors: Klaudija Lončarić [2]; Laura Sutlović [3]; Nataša Erceg [1]; Rajka Jurdana-Šepić [2]; Velimir Labinac [2]

[1] *University of Rijeka, Faculty of Physics*

[2] *University of Rijeka, Faculty of Physics, Croatia*

[3] *(2) Elementary school Juraj Klović, Tribalj; Elementary school Ivan Goran Kovačić, Čepić; Elementary school Fran Krsto Frankopan, Krk, Croatia*

Corresponding Author: nerceg@phy.uniri.hr

The digital repository of 96 experiments for physics and science teaching was created with the intention of organizing e-content realized at the Faculty of Physics (University of Rijeka, Republic of Croatia) during the pandemic period as part of two courses for primary education and physics teacher studies. The content enables the application of innovative teaching methods in a virtual environment (e.g. the station rotation model - the inclusion of all students in the rotation of online and classroom activities and the flipped classroom model). The repository is aimed at pupils, students and physics teachers in primary, secondary and higher education.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Oral presentations / 308

Approaching Quantum Technologies for Secondary School Students and Their Teachers

Author: Zdeňka Koupilová[None]

The incorporation of quantum technologies into secondary school curricula is of growing importance. Nevertheless, this necessitates that high school teachers acquaint themselves with these topics as well. This paper presents insights gained from a series of short-term lectures and long-term courses on the fundamentals of quantum technologies, aimed at upper-secondary school students. A course for in-service physics teachers is currently being prepared based on this experience. The contribution will include specific ideas as well as approaches that can be used to cover the topic at that basic level.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 5

Effect of the group size on student learning using an active learning methodology in a science class

Author: Arturo Pazmino[None]

Co-authors: Eduardo Montero [1]; Esther Gutierrez [1]

[1] *Escuela Superior Politecnica del Litoral*

Peer-project learning is an active methodology applied to one university in Ecuador, and it has improved students'learning process in Physics. The main goal of this research is to provide a first analysis of the effect of the team members' number, working on a real-life project, on the understanding of electromagnetism. An introductory electromagnetism course for engineering students was taken. The grades of an electromagnetism test were taken to quantify the students'understanding. As a result, the number of team members doesn't influence the acquired knowledge if every member works on the project with a medium effect size.

How would you like to present your contribution?:

Hybrid from my own country (later in the conference day, best for Americas)

Target education level:

University

Category:

Formal Education

Oral presentations / 54

Interdisciplinary approaches to foster the learning of contemporary physics topics at high school

Author: Matteo Tuveri[None]

Corresponding Author: matteo.tuveri@ca.infn.it

We discuss interdisciplinary approaches and their role in bringing contemporary physics topics to high school, fostering students' motivation and interest in physics. We make an explicit example of an innovative educational program devoted to secondary school students (16-19 years old) to introduce them to gravitational physics-related topics using storytelling. We illustrate and discuss our design and methodology. We present results from the experimentation of such approaches in scientific and humanities high schools, focusing on the potentiality of our approach in orientating students towards a STEM career.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Informal Education

Oral presentations / 42

From Quantum Optical Experiment to Description Using Dirac Notation in Physics Classrooms - Results of an Acceptance Survey

Author: Fabian Hennig[None]

Co-authors: Kristóf Tóth ; Philipp Bitzenbauer

Corresponding Author: fabian.hennig@fau.de

According to the curricular changes, quantum physics is going to be given more importance in teaching Physics in secondary schools. The quantum object photon is introduced and discussed. A further study will investigate whether a reduced mathematical formalism can enhance students' understanding of the concept. The instructional elements of the learning sequences developed for this purpose have been tested on a pilot basis and the results are presented here.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 61

A feasibility study to develop chain computerized adaptive testing for the Force Concept Inventory

Author: Jun-ichiro Yasuda[1]

Co-authors: Michael Hull [2]; Naohiro Mae [3]; Kentaro Kojima [4]

[1] *Nagoya University*

[2] *University of Alaska Fairbanks*

[3] *Osaka University*

[4] *Kyushu University*

Corresponding Author: baryogenesis@gmail.com

Assessment tests are commonly used to measure the pedagogical effect. To shorten the test length, we previously suggested the use of computerized adaptive testing (CAT). Based on the study, we propose increasing the frequency of CAT-based assessments during the course, while further reducing the test length per class, thus decreasing the total number of test items during the course. For that purpose, we utilize a CAT algorithm including collateral information, which we call Chain-CAT. We present the design of the algorithm, a preliminary result of analysing its efficiency by numerical simulation and discuss the feasibility of this system.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 201

Embracing Complexity –Computational Essays in Fostering Authentic Scientific Reasoning

Author: Peitsa Veteli[1]

[1] *Helsinki Institute of Physics (FI)*

Creating a scientifically literate population requires insight into how scientific thought is developed and put into practice. Computational essays can provide structural support for acquiring such argumentation skills through data-based reasoning while promoting the students'epistemic agency. With open data, this method can provide a valuable, authentic and easily accessible experience of

scientific work in modern and varied contexts. We present a pilot look at a pre-service teacher course combining field work, expert lectures and data analysis, exploring how the medium of computational essays can be used to foster a deeper understanding of empirical sciences.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 320

SARA BARBIER AWARD ”Be like Izaac Newton” - science project as a method of introducing students with special educational needs to work in a new class on the first year of secondary school during physics lessons

Author: Joanna Biel-Kiepura[1]

[1] *Zespół Szkół nr 6 we Wrocławiu*

The physics research project “Be Like Isaac Newton” supports students’ development through multidirectional activities around concepts such as creativity, innovation, and discovery through experimentation. It was planned to increase knowledge of dynamics. The project’s experimental set is inspired by the environmental trend of “zero waste.” The project combines skills in physics, mathematics, and technical and construction skills. The project was implemented with 19 15-year-olds in the first year of high school, six of whom had special educational needs evaluations.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 73

Enhancing Student Engagement in a Measurement and Control Laboratory Course: Design Strategies and Implementation

Author: Mirela Kaczmarek[1]

Co-authors: Błażej Gołyszny [1]; Piotr Wieczorek [1]; Radosław Wasielewski [1]

[1] *University of Wrocław*

The paper presents considerations for designing the Measurement and Control Laboratory course taught at the Faculty of Physics and Astronomy at the University of Wroclaw, aimed at experimental physics students and students of Applied Computer Science and Measurement Systems. Both course content and hardware solutions as well as choice of teaching methods are considered. The design of the course has been the subject of evaluation by the participants of the course. Further changes were proposed on this basis, taking into account the observations of the lecturers.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 176

Classroom network analysis for pedagogical decision-making in Physics and Science Education

Author: Javier Alejandro Pulgar Neira[1]

Co-authors: Carmen Espinoza [2]; Francisco Salinas [3]; Iván Sánchez [1]; Pablo De Ruyt [4]

[1] *Physics Department, Universidad del Bío Bío (UBB), Concepción 4051381, Chile; Grupo de Investigación en Didáctica de las Ciencias y Matemática (GIDICMA), UBB, Chile.*

[2] *Didactics Department, Universidad Católica de la Santísima Concepción, Concepcion, Chile*

[3] *Physics Department, Universidad de la Frontera, Temuco, 4811230, Chile.*

[4] *Grupo de Investigación en Didáctica de las Ciencias y Matemática (GIDICMA), UBB, Chile*

Corresponding Author: jpulgar@ubiobio.cl

We explore how educators interpret classroom sociograms and use their network related ideas to inform pedagogical decisions. A workshop titled CLASSNET was designed upon network research evidence in education and collaborative learning techniques (CLTs). CLASSNET was implemented during 2022 and 2023 on a sample in-service (43) and pre-service science teachers (136). Qualitative analysis of their pedagogical decisions during 2022 led to the revision of CLASSNET's content in 2023, where we added CLTs and group-level activities. Results highlight the need for network-based protocols for group formation, and the tendency for posing prescribed teaching methods while overlooking the classroom social ecology.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Oral presentations / 127

Teachers TPACK: promoting self-monitoring in physics problem solving through digital activities

Authors: Smadar Levy[None]; Edit Yerushalmi[1]; kana ofir[1]

[1] *Weizmann Institute of Science*

A variety of research-based instructional strategies have been designed to promote students'self-monitoring in physics problem solving but few are implemented, either because of structural constraints or teachers'perceptions. Although digital activities can help teachers cope with structural constraints their perceptions may still pose a challenge. In this study we focused on teacher leaders and their experiences with digital activities in a professional learning communities program and in their high school physics classrooms. Interviews with 10 teacher leaders revealed that while they acknowledged the positive aspects of these activities, they overlooked their role in promoting self-monitoring in physics problem solving.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 203

Orienting the young in the complexity of climate change to foster agency and decision-making in societally relevant choices

Author: Giulia Tasquier[1]

Co-authors: Francesca Pongiglione [2]; Elena Claire Ricci [3]

[1] *University of Bologna*

[2] *San Raffaele Vita-Salute University*

[3] *University of Verona*

Recent reports highlight that general population seems increasingly aware of climate change. However, forms of radical activism are showing a lack of orientation among young people, who have trouble understanding deeply the complexity of the issue and how to become agents of change. There is a lively research debate, across several disciplines, about how to conceive agency in the field of climate change. The overarching goal of this study is to respond to these phenomena by unpacking the concept of agency from three disciplinary perspectives, including both individual action and political participation, and incorporate it in science education programs.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **12**

What correlates with persistence of undergraduate women?

Authors: Maxwell Franklin[1]; Eric Brewe[1]

[1] *Drexel University*

Retention of women remains a persistent problem in physics. Using survey results obtained at the American Physical Society (APS) Conference for Undergraduate Women in Physics (CUWiP), we tested several affective factors to find how they correlate with retention at several stages of physics. These factors are motivation, sense of community, sense of belonging, perceived recognition, identity, interest, and performance competence. We find that identity, interest, perceived recognition, and certain factors of motivation are all highest in women that stay in physics post-university, while sense of belonging is highest in women that leave the field after graduating with a physics degree.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Oral presentations / **123**

A didactic pathway on the concept of energy in primary school: cognitive well-being and self-efficacy based on gender

Author: Giusy Giarratano[None]

Co-authors: Onofrio Rosario Battaglia ; Giulia Termini ; Claudio Fazio [1]

[1] *Università degli Studi di Palermo*

Corresponding Author: giusy.giarratano@unipa.it

The main focus of this research is to investigate the gender gap in learning processes in physics in five classrooms of sicilian primary school. After analysing the data reported in the literature related to the gender gap in learning processing, we discuss the results of a didactic pathway on the concept of energy, based on the IBSE methodology, conducted with 10-year-old pupils. We discuss the answers to a questionnaire on self-efficacy and approach to scientific disciplines, administered before and after the didactic pathway, that we realized for primary school, focusing on the differences emerging from male and female pupils.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Formal Education

Oral presentations / **326**

IBL on physics lessons ... in the eyes of students

Author: Malgorzata Szymura[1]

[1] *Zespół Szkół w Czerwionce-Leszczynach*

In my school, I guided a pedagogical innovation, called: High school student as a scientific researcher. I chose one 1st class where I taught one out of four lessons per month using the IBL method., from October 2018 until April 2019. During the implementation, I conducted my Practitioner Inquiry to get the answer: How do students perceive IBL in physics lessons? I performed surveys, tests, and interviews with students. I prepared recordings of my lessons and analyzed student responses. During my presentation, I will present the results of these tests, my conclusions, and my recommendations for further work.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **91**

Design of a narrative approach for teaching/learning uncertainty in Climate Change Education

Authors: Emma D'Orto[None]; Giulia Tasquier[1]

[1] *Università di Bologna*

Climate Change (CC) is severely impacting society's culture, questioning modern human relation with planet Earth, our perception of time and the way we conceptualise and deal with uncertainty and risk. This study aims at identifying and analysing what we call "narrative lines"of CC discourse, in order to implement an educational approach that adopts a narrative perspective in teaching/learning how to deal with uncertainties of CC.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 80

Pro-environmental Characterization attitudes of natural sciences and physics teachers in training

Author: Diego Fernando Becerra Rodriguez[1]

[1] *La Sabana University*

Given that environmental pollution is one of the main challenges facing humanity, a qualitative, exploratory research is presented, which, through an adapted version of 15 questions from the EAPA test, characterizes the pro-environmental attitudes of 20 science and physics teachers in training in Chía, Cundinamarca, Colombia. The results show that pre-service teachers recognize that fostering environmental awareness in themselves and in their future students constitutes an alternative to halt the deterioration of the planet. Finally, there is an identified need to evaluate how to teach students to carry out daily activities without affecting ecosystems in a sustainable manner.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 56

Gatekeepers: The Role of Physics Teachers in Latino Women's Physics Identity Development

Author: Rocío Lucero[1]

Co-author: Corina Úrsula González Weil [1]

[1] *Pontificia Universidad Católica de Valparaíso*

Corresponding Author: rocio.lucero@pucv.cl

This study highlights the significant influence of physics teachers on women´s physics identity development. Identity, within the educational realm, is understood through the lens of recognition within a specific context, with an additional emphasis on performance in the field of physics. We explore the impact of external validation by teachers on physics identity, through the biographies of six South American female physics teachers. Furthermore, we illuminate the pivotal role of certain educators, gatekeepers, in guiding and supporting students towards physics. These people contribute to the adaptation to new institutional cultures and open gates to Physics.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / **11**

Making Teaching Physics Cultural –a New Paradigm and its Application in a Summary Lecture

Author: Igal Galili[1]

[1] *The Hebrew University of Jerusalem*

Physics teaching widely varies in strategy and content in addressing various populations of students at their level, goals, interests. We have developed a new approach to the structure of physics course which is appropriate for broad range of levels and goals. It implies a universal demand of identification knowledge items, the structure of a theory based knowledge. The curriculum should represent Nucleus, Body and Periphery of the theory. It is the latter that makes knowledge cultural. We illustrate by a summary lecture in school mechanics which demonstrated significant impact on students' knowledge, its holistic perception and nature.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **67**

Voluntary online content discussion seminars as potential avenues of teacher communities of practice

Author: Deepa Chari[None]

Co-author: Sarita Kamat

There is much known about the outcomes or features of a developed community of practice, in general, and also about the teacher communities, however, there is less clarity on how such a teacher community emerges. We believe that the initial stage is the most important one as it is the deciding stage for the fate of the teacher community of practice.
In this study, we report the perspectives of teacher participants from a series of year-long, voluntary online discussion sessions on school science and mathematics in India to understand the nature of emerging communities of practice.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Informal Education

Oral presentations / 153

Redesigning a lab for engineering students using virtual and face to face activities

Authors: Cecilia Stari[None]; Lorenzo Lenci[None]

This work presents the redesign of the Electromagnetism laboratory for engineering careers, incorporating distance activities using remote laboratories and simulators to complement the classroom activities in the laboratory. The inclusion of these activities allows for better use of class time and better preparation of students. It also contributes to the understanding of the concepts and the use of the instruments, since their use can be adapted to the time needed by each student, repeating the activity if necessary, without having the time limit of the classroom.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 216

Studying the relationship between performance and confidence in physics and mathematics

Author: Stefania Lippiello[None]

Co-author: Ornella Pantano [1]

[1] *Dipartimento di Fisica e Astronomia, Università degli Studi di Padova*

Corresponding Author: stefania.lippiello@phd.unipd.it

This study focused on the relationship between mathematics and physics education and students' confidence when using mathematical tools such as derivatives, integrals, and vectors to solve problems. We conducted a longitudinal study with 260 secondary school students, who were given a modified version of the Test of Calculus and Vectors in Mathematics and Physics. The results showed an overall improvement in test and confidence scores but did not lead to a balance between over-confidence and under-confidence. Males showed consistently more confidence than females. This research highlights the importance of working on confidence assessment practices alongside performance in academic achievements.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 328

How does the use of one's own notes during tests affect students' performance in physics?

Author: Anna Bekas[1]

[1] *Szkoła Podstawowa Nr 62 im. kmdra por. Franciszka Dąbrowskiego w Krakowie*

Corresponding Author: bekas.anna.sp62@gmail.com

As part of the STAMPEd project, an educational survey was conducted using the Practitioner Inquiry (PI) strategy. Attempts were made to answer the research question during the implementation of two sections: Mechanical vibrations and waves and Electrostatics in classes of 14-year-olds. To sum up each section, the students wrote tests to check their knowledge - once using their own notes, and once without them. The average results of the students were compared with each other. When conducting the evaluation survey, the focus was on obtaining information regarding students' opinions on the forms and methods of conducting tests.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Formal Education

Oral presentations / 23

Quantum Technology as Occupational Field: Twofold Practice in Physics Teacher Preparation

Author: Gesche Pospiech[None]

Co-authors: Julia Unger [1]; Moritz Förster [1]

[1] *TU Dresden*

As a high demand for specialists in the field of quantum technologies is expected, interest in this area should be encouraged at school. Teachers play a central role in this: they should be empowered to design lessons that introduce pupils to this topic and provide insight into corresponding

professional contexts. To this end, a university course has been designed integrating theoretical basics, personal experiences through a didactic industrial internship in quantum technology companies and designing corresponding own lessons. By semi-structured interviews, we investigate the course's influence on prospective teachers' attitudes and knowledge. We present the analysis of the interview data.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 147

In-field and out-of-field teachers' integration of a Massive Open Online Course in kinematics into their instruction of physics

Authors: Asnat R. Zohar[1]; Inbal Ston[1]; Shulamit Kapon[1]

[1] *Technion - Israel Institute of Technology*

We developed a Massive Open Online Course (MOOC) in Kinematics for secondary school students. We present findings from a study that examined its implementation in classrooms taught by in-field (i.e., teachers with strong academic background in physics) and out-of-field teachers (i.e., teachers with limited background in physics and its teaching). Data include semi-structured interviews with 11 teachers (7 out-of-field, OoF, and 4 in-field teachers, IF) and data mining of their students'(N=391) work in the course.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 237

How challenging is it to extract information from different representations

Authors: Ana Susac[1]; Katarina Jelicic[2]; Maja Planinic[2]; Marijan Palmovic[3]

[1] *University of Zagreb, Faculty of Electrical Engineering and Computing*

[2] *University of Zagreb, Faculty of Science*

[3] *University of Zagreb, Department of Speech and Language Pathology*

We investigated the impact of different representations on answering conceptual questions in physics using eye tracking. Students' scores and eye-tracking measures were compared across graphical, pictorial, and verbal representations in isomorphic questions. High school students were rather consistent in their answers across all representations, with no significant score differences. However, eye-tracking data revealed that extracting information was easiest from verbal representations and most challenging from pictorial ones. These findings can inform teachers and researchers about the challenges students face with specific representations and assist them in teaching with diverse representations.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **227**

Pedagogical Model for Teacher Education on Climate Change

Authors: Athina Ginoudi[1]; Clemente Rossi[2]; Dimitris Stavrou[3]; Eleonora Barelli[None]; Emily Michailidi[3]; Emma D' Orto[2]; Francesco Martinelli[4]; Giorgia Bellentani[4]; Giulia Tasquier[2]; Ioannis Metaxas[3]; Janina Taurinen[5]; Jari Lavonen[5]; Katja Lauri[5]; Laura Riuttanen[5]; Maria Kanakidou[3]; Nikos Kalivitis[3]; Olivia Levrini[2]; Stefania Zampetti[4]; Suvi Lintuvaara[5]; Thalia Tsaknia[6]

[1] *Regional Directorate of Primary and Secondary Education of Crete*

[2] *University of Bologna*

[3] *University of Crete*

[4] *Fondazione Golinelli*

[5] *University of Helsinki*

[6] *Ellinogermaniki Agogi*

In the contribution we present the pedagogical model developed within the Erasmus+ Teacher Academy called CLIMADEMY, coordinated by the University of Crete (https://climademy.eu/). In the project, a comprehensive training framework for in-service and pre-service teachers has been developed to support the teachers in understanding Climate Change drivers and impacts, mitigation and adaptation actions, and to promote their efficiency in teaching and learning about Climate Change. The pedagogical model was built to align policy documents, school constraints, teacher needs and to pursue the goal of generating a new school ecosystem through the creation of inter-transdisciplinary boundary zones.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 219

Online Laboratory –Equipped with Procedural understanding Perspective

Author: Shirish Pathare[1]

Co-authors: Saurabhee Huli [1]; Bhagyashri Latad [2]

[1] *Homi Bhabha Centre for Science Education*

[2] *Mukangan Exploratory*

During the pandemic, educational institutions implemented online laboratory options, adapting formats based on available resources. Our approach diverges from traditional instruction-centric models, focusing on fostering procedural understanding. Through interactive webpages, we aim to engage students in critical thinking and problem-solving. Our online laboratory empowers students to make decisions regarding instrument selection, data collection, and analysis. Visit https://shirishpathare.com for access. We believe that these online resources, born out of necessity during the pandemic, possess significant potential to enhance students' procedural understanding and prepare them for real-world laboratory experiences.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 14

Bias in peer recognition does not explain differences in how men and women perceive their recognition in physics courses

Author: Meagan Sundstrom[None]

Co-author: Natasha Holmes [1]

[1] *Cornell University*

Gaining recognition as a physics person from peers is an important contributor to undergraduate students' persistence in physics courses. Previous research has separately demonstrated that women perceive less peer recognition than men (perceived recognition) and that women receive fewer nominations from their peers as strong physics students than men (received recognition). The relationship between perceived and received peer recognition, however, is not well understood. Here we present a large-scale study of over 1,600 introductory physics students at several US institutions. Results show that, for students receiving the same amount of recognition, women report significantly lower perceived recognition than men.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 143

Does inquiry-based teaching make a difference? Results of the research project on wave optics (INVESTIGATE)

Authors: Lana Ivanjek[1]; Maja Planinic[2]

Co-authors: Ana Susac ; Karolina Matejak Cvenic [3]; Katarina Jelicic [4]

[1] *JKU Linz*

[2] *Department of Physics, Faculty of Science, University of Zagreb*

[3] *Department of Physics, Faculty of Science, University of Zagreb, Bijenička c. 32, 10000 Zagreb, Croatia*

[4] *Department of Physics, Faculty of Science, University of Zagreb, Croatia*

The results of the project, comparing the effectiveness of inquiry-based vs. lecture-based teaching of wave optics, will be presented. An inquiry-based teaching sequence, spanning eight 45-minute sessions, was designed and implemented. The sequence incorporates four investigative student experiments exploring interference, diffraction, and polarization of light, complemented by teacher demonstration experiments. The teaching sequence was implemented in six Croatian secondary school classes and compared with traditional lecture-based instruction in six control group classes from the same schools. Results of the Conceptual Survey on Wave Optics indicate that the experimental group outperformed the control group in four out of five conceptual areas.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 197

Introduction of the multipurpose instrument Meter ZD1301A

Author: Arpad Bordas[None]

Co-authors: Maja Stojanovic ; Peter Farago ; Zoltan Nagy

The Meter ZD1301A is an affordable multipurpose instrument designed for classroom demonstrations and basic experiments. The device can function as a stopwatch, event counter, RPM meter, digital frequency meter and gamma counter. External components such as photogates, TTL cable for frequency measurements and a Geiger tube can be connected to the device. By introducing our instrument, we hope to encourage physics teachers and students to design and build their own simple laboratory devices.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / **137**

Diving into Quantum Physics: Challenging the Constraints of Knowledge Transfer Through Engaging School Lab Units

Author: Manuel Schleicher[None]

Co-authors: Julia Thurner-Irmler ; Marietta Menner ; Olaf Krey

The following contribution is part of the outreach project of the Transregional Collaborative Research Center (TRR360) that revolves around Constrained Quantum Matter (ConQuMat). To shed light on quantum physics and inspire curiosity among young minds we create three interactive and engaging school lab units bridging the gap between school physics knowledge and high-end quantum matter research. With our first School Lab Unit conducted in the DLR_School_Lab at the University of Augsburg we aim to broaden the students understanding of magnetism. The unit-structure and our evaluation priorities are outlined. First results will be added for our poster presentation at the conference.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Non-formal Education

Poster session / **107**

CREDO-edu programme for schools –our way to introduce kids to modern physics and engage in scientific research.

Author: Melania Deresz[1]

Co-authors: David Alvarez-Castillo [2]; Ophir Ruimi [3]; Piotr Homola [4]; Sławomir Struglik [2]

[1] *Faculty of Physics, University of Warsaw*

[2] *Institute of Nuclear Physics Polish Academy of Sciences*

[3] *Racah Institute of Physics, Hebrew University of Jerusalem*

[4] *Institute of Nuclear Physics Polish Academy of Sciences, AstroCeNT, Nicolaus Copernicus Astronomical Center Polish Academy of Sciences*

Corresponding Author: mderesz@fuw.edu.pl

Cosmic Ray research is a new branch of physics and astrophysics, which was not known until their discovery in 1912 by Victor Francis Hess [1]. Its deeper understanding has been possible through the development of electronics and detectors. Therefore it was rarely introduced to school curricula. Our CREDO-edu program will reverse the trend of avoiding 20th-century discoveries in physics lessons. We created an application dedicated to conducting cosmic rays measurements [2] in schools and home environments. Moreover, we prepare a programme of year-round school lessons that fully engage teachers on how to familiarise students with cosmic ray phenomena.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 291

The laws of physics taught through their application - not as difficult as they seem.

Author: Hanna Kościelny[1]

Co-authors: Daniel Dziob [1]; Jolanta Rokosz [1]

[1] *Aviation Education Centre Krakow Airport*

The laws of physics are perceived as complicated, and difficult to explain. Popular media and school textbooks do provoke some issues perceived as challenging to understand. In general opinion, it is a disliked and complicated subject. We show that one of the solutions to this problem is to show students the practical application of physics in the fascinating field of aviation. An example is a workshop during which we explain why mass distribution in an airplane is important and what torque has to do with it. This is what we try to do at the Aviation Education Center.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Non-formal Education

Poster session / 34

Factors of quality of physics demonstrations

Authors: Alexandr Nikitin[1]; Marie Snětinová[1]; Petr Kácovský[1]

[1] *Department of Physics Education, Faculty of Mathematics and Physics, Charles University, Prague*

This paper describes a video study of physics demonstrations for upper-secondary school students from the perspective of parties relevant in physics education –physics teacher trainers, pre-service physics teachers, in-service physics teachers and upper-secondary students. The video-recordings of the performances are divided into numerous short sections, which are evaluated on prepared rating scales. Results show that the overall impression of short sections is mainly influenced by the atmosphere in the auditorium. Other relevant factors are the clarity of lecturer's speech and the clarity of experiments. These factors explain about 85% of the variance in the overall impression of these sections.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Non-formal Education

Symposium / **149**

Equipping Teachers to Support Student Reasoning about Everyday and Complex Phenomena

Authors: Chara Bitsaki[None]; Emily Michailidi[1]; Federico Corni[2]; Stamatis Vokos[None]

[1] *University of Crete*

[2] *Free University of Bozen-Bolzano*

This symposium is proposed by the GIREP Thematic Group "Physics Preparation of Teachers in Grades K-6"and consists of a discussion of two approaches to teacher education and professional development in elementary school grades, as well as secondary school grades. The first contribution illustrates how imaginative understanding of forces of nature and their interactions provides a pathway to complexity in natural systems. The last two contributions describe research-based efforts to prepare teachers to support explanations of complex phenomena associated with climate change.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Symposium / **185**

Development of digital teaching scenarios on advanced STEM topics for teacher education

Authors: Argyris Nipyrakis[1]; Athanasia Kokolaki [1]; Dimitris Stavrou[1]; Dirk Brockmann-Behnsen[2]; Eilish McLoughlin[None]

[1] *University of Crete*

[2] *Leibniz University Hannover*

STEM Digitalis project aimed at the development of blended and distance learning environments for pre-service science teachers in advanced STEM topics. Consequently, five teaching scenarios about contemporary scientific topics have been developed, to facilitate pre-service teachers'conceptualization of STEM learning and to provide them with learning experiences, supporting the development of their digital competencies. Three contributions of the proposed symposium are focused on the implementation of the teaching scenarios, focusing on the use of digital technologies for teaching STEM topics in blended and distance learning environments, while the fourth contribution discusses insights of these implementations into pre-service teachers training programs.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Symposium / 249

Energy, Energy Degradation and Entropy: Conflicting Views of These Concepts in the Teaching of Thermal Phenomena

Authors: Alessandra DE ANGELIS[1]; Avraham MERZEL[2]; Boaz Katz[3]; David PERL[4]; David Sands[None]; Edit Yerushalmi[5]; Efrat Blau Barak[6]; Fadi Sakran[7]; Lorenzo Santi[1]; Marisa Michelini[None]; Paula Heron[None]; Uri BERNHOLZ[3]; Yaron Lehavi[8]; Zeev KRAKOVER[4]

[1] *Dept. of Mathematics, Physics and Computer Science, University of Udine*

[2] *The Hebrew University of Jerusalem*

[3] *Dept. of Particle Physics and Astrophysics, Weizmann Institute of Science*

[4] *Dept. of Science Teaching, Weizmann Institute of Science*

[5] *Weizmann institute*

[6] *Weizmann Institute Of Science*

[7] *The Beit Berl college of Education*

[8] *The David Yellin Academic College of Education*

This symposium will look at the difficult concepts of energy and entropy and examine different approaches for addressing them in the teaching of thermal phenomena. The law of conservation of energy is one of the most important laws in classical physics, but the common conception of the Second Law as the law of increasing entropy would suggest to some that entropy is the more important quantity. The first presentation will examine the nature of entropy, the second will address experts' views regarding energy, and the following two will present examples of different approaches to teaching energy at different levels.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Discussion workshop / 230

Physics and Physics' Education, as a means of conceptualizing, interpreting and opposing to warfares internationally. Physics Education and Education for Peace"

Author: Aristotelis Gkiolmas[1]

Co-authors: Aikaterini Benisi ; Anthimos Chalkidis ; Vasiliki Psoma ; Ilias Boikos ; Gianna Katsiampoura ; Constantine Skordoulis ; Zografia Papanagiotou ; Alexandra-Triantafyllia Papanagiotou ; Argyro Toliou ; Polina-Theopoula Chrysochou ; Luisa Lovisetti [2]; Soumitro Banerjee [3]

[1] *Department of Pedagogy and Primary Education, National and Kapodistrian University of Athenc, Greece*

[2] *University of Milan, Department of Physics*

[3] *Indian Institute of Science Education & Research, Kolkata, India*

Physics Education is strongly related to moral and ethical issues, the role of scientists in the society, as well as with Active Citizenship. Thus, in teaching Physics, the conceptualization of war and the advancement and establishment of peace, worldwide, are both central issues. This proposed Discussion Workshop (of the GIREP Thematic Group "Physics and Society"), invites participants and contributions about: teaching nuclear energy, teaching the destructive results of weapons, teaching and learning the moral and ethical role of physicists as scientists, teaching about the distribution of resources worldwide as a cause for war, as well as other possible topics.

How would you like to present your contribution?:

Hybrid from my own country (early in the conference day, best for Asia, Australia)

Target education level:

General

Category:

Formal Education

Workshop / 223

Shaping physics teacher education together: How to successfully connect didactics and scientific discipline?

Author: Sebastian Schellhammer[1]

Co-author: Frank Beier [2]

[1] *(1) Dresden Integrated Center for Applied Physics and Photonic Materials (IAPP) and Institute for Applied Physics, Technische Universität Dresden, 01062, Dresden, Germany*

[2] *(2) Chair of School Education, Technische Universität Dresden, 01062, Dresden, Germany*

Collaboration between educational science and physics as a scientific discipline ensures successful and competence-based physics teacher education. However, best practices for synergistic didactic concepts are widely missing. In the module "Applications in physics and their didactics", concepts from physics didactics and insights into current physics research are strongly entangled to create a holistic learning environment for advanced teacher students. Along the experiences we made within the development and implementation of this didactic concept, this workshop discusses reasons for the limited collaborations between the individual disciplines and creates strategies for overcoming them to establish a synergistic physics teacher education.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Workshop / **7**

"Tuneable"levitating pencil

Author: Leoš Dvořák[None]

Participants of the workshop will build a simple device in which a pencil levitates due to the repulsion of permanent magnets. The advantage of this construction over those described on various websites is that some parameters can be set, namely the distance of magnets under the pencil and the number of these magnets. This enables to investigate how the behaviour of the pencil (the height in which it levitates, its stability, oscillations etc.) depends on the parameters. Both the theory behind the tool and the possibilities of its use in physics teaching and learning will be discussed in the workshop.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Workshop / **252**

Pixel detector based particle camera as a motivation tool for practical physics education demonstrating properties of radiation and elementary particles in a comprehensible way

Authors: Michael Holik[1]; Stanislav Pospisil[2]; Vladimír Vícha[3]

[1] *IEAP CTU in Prague, FEE UWB in Pilsen*

[2] *Institute of Experimental and Applied Physics, Czech Technical University in Prague*

[3] *IEAP CTU in Prague; Gymnazium, Pardubice, Dasicka 1083*

Practically oriented teaching represents inestimable means in motivation of students to boost their interest in understanding. Especially when focusing on technically oriented subjects. The educational kit SESTRA (School Educational Set with Timepix for Radiation Analysis) has been developed at IEAP CTU in Prague with intention to allow simple access of students to microcosmos experiments practicable in regular classes. The kit includes the particle camera supplemented with a wide set of accessories and detailed guidelines. The proposed workshop aims to provide live demonstrations in order to reveal the full potential of the kit via exemplary hands-on exercises guided by skilled lectors.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Non-formal Education

Workshop / 159

Floating and Melting of Ice in Oil

Author: Mojca Čepič[1]

Co-author: Nina Amini Košmrlj [2]

[1] *University of Ljubljana, Faculty of Education*

[2] *Osnovna šola Kolezija, Ljubljana, Slovenia*

The workshop investigates position and orientation of ice during melting in two immiscible fluids, the water, and the oil. The theoretical calculation of position of ice using Archimedes law cannot account for orientation of the ice cube. In addition, observations are not consistent with calculated predictions, and this experimental workshop will allow to find the reasons for this inconsistency.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / 48

High School Teachers' Perspectives on Teaching Quantum Physics –Questionnaire Design

Author: Jana Legerská[1]

[1] *Department of Physics Education, Faculty od Mathematics and Physics, Charles University*

The role of quantum physics in the high school curriculum has been emphasized recently. However, the curricular documents cannot bring a complete picture of incorporating quantum physics into the school reality. In this paper, we present a quantitative questionnaire for high school physics teachers as a research tool for investigating the current state of teaching quantum physics at high schools around the Czech Republic in more details. Collecting responses from 263 teachers, we found that 79% of them dedicate to quantum physics in their teaching. In further research, we focus on outlining the typical teaching time, teaching goals, topics, etc.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 293

Field game about Mad Scientist - learning physics through fun.

Author: Karolina Guśtak[1]

Co-authors: Daniel Dziob [1]; Hanna Kościelny [1]; Jolanta Rokosz [1]

[1] *Aviation Education Centre*

Corresponding Author: karolina.gustak@krakowairport.pl

Our poster shows the educational game “Mad Scientist”. We organised it, among others: during summer camps at the Aviation Education Center. We have presented knowledge of physics in a scenario related to discovering inventions and getting to know scientists. Through elements of competition and fun, we tried to provide kids not only with knowledge, but also with the method of inquiry through discovery and experimentation. One particular type of game is a field game, in which each point is located in a different place and is required to be found.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Non-formal Education

Poster session / 202

Weekend Lab Challenges bring physics learning from the laboratory into everyday life

Author: Shinjiro OGAWA[1]

[1] *WASEDA University High School*

An inquiry-based teaching programme was developed to have students work on Weekend Lab Challenges with the aim of enabling students to develop a view of what they learn in secondary school physics lessons that they can use in their daily lives and in their future lives.
Working on challenges at home not only brings physics learning out of the laboratory and into everyday life, but also allows students who are interested in what they are learning to take the time to try it out, thus both improving student agency and realising inquiry-based learning.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 142

Surveying teachers' readiness to incorporate digital technologies in inquiry-based laboratories: the development of a tool and initial findings

Author: Marta Carli[None]

Co-authors: Ornella Pantano [1]; Peppino Sapia ; Giovanni Organtini [2]

[1] *Dipartimento di Fisica e Astronomia, Università degli Studi di Padova*

[2] *Sapienza Universita e INFN, Roma I (IT)*

Corresponding Author: marta.carli.1@unipd.it

The ADELANTE national project aims at facilitating the adoption of investigative laboratories enhanced by digital technologies in secondary school. A country-wide network of 16 "teacher leaders" was established to develop teaching-learning sequences featuring digitally enhanced laboratories, to be shared with a wider community of teachers in the next phase. To monitor teachers' competences across the program, a survey was developed. This contribution outlines the criteria and process for the construction of the survey and illustrates the results of its administration to the teacher leaders at the beginning of their professional development journey.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / **241**

Bridging the Gaps: How physics teachers in Slovakia utilize non-formal resources for astronomy education

Author: Viera Haverlikova[1]

Co-author: Tünde Kozánek Kiss

[1] *Comenius University in Bratislava, Faculty of mathematics, Physics and Informatics*

While astronomy is not a standalone subject in the Slovakian educational system, some astronomy concepts are integrated within Physics courses. This study explores how teachers utilize non-formal educational resources to supplement physics instruction and their perspectives on incorporating astronomy. Data from a survey of 33 teachers reveal that while many recognize astronomy's appeal, time constraints and lack of resources are deterrents. In planning a visit of an observatory, teacher expect lectures, films, and sky observation, with less emphasis on interactive engagement. Findings suggest a need for interventions to enhance teacher awareness of non-formal astronomy resources and promote interactive teaching methods.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Non-formal Education

Poster session / **234**

Developing Pupil's Ideas related to the Concept of Force in the 1st Year of Gymnasium

Author: Silvia Novotná[None]

Co-author: Peter Demkanin

This contribution offers preliminary ideas for creating a part of a higher secondary school educational program aimed at the holistic development of students. The ideas we illustrate by development of the concept of force, as found in several traditional topics of physics education. We ground our work on the neuroscience view of learning as formulated by T. Tokuhama-Espinosa, and the concept of force development we ground on the fact that pupils commonly encounter it in everyday life. We also illustrate the target level, where we want students to get, and an example of activity used in such development.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / **294**

Novel technologies as facilitators of learning process - inspirational examples from Aviation Education Center Krakow Airport

Authors: Daniel Dziob[1]; Hanna Kościelny[1]; Jolanta Rokosz[1]; Karolina Guśtak[1]; Karolina Klima[1]; Monika Orzeł[1]; Natalia Krawczyk[1]; Sylwia Orzeł[1]

[1] *Aviation Education Centre Kraków Airport*

We live in a time of enormous technological progress that cannot be ignored or stopped. It affects every sphere of human activity, including education. Therefore, teachers face an increasing challenge in motivating students, especially in physics. Classic experiments are often difficult to perform using outdated experimental equipment and cannot compete with the stimulating environment. Our Aviation Education Centre (CEL) presents new technologies that contribute to action-oriented education of students, and also provide a deeper understanding of physical phenomena and increase the attractiveness of classes.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Non-formal Education

Poster session / **152**

CLImate change teachers'acaDEMY (CLIMADEMY)

Author: Ioannis Metaxas[1]

Co-authors: Athina Ginoudi [2]; Chara Bitsaki ; Dimitris Stavrou [1]; Eleonora Bareli [3]; Emily Michailidi [1]; Giorgia Bellentani [4]; Giulia Tasquier [3]; Jari Lavonen [5]; Laura Riuttane [5]; Maria Kanakidou [1]; Mihalis Vrekousis [6]; Nikos Kalivitis [1]; Olivia Levrini [3]; Sofoklis Sotiriou [7]; Thalia Tsaknia [7]

[1] *University of Crete*

[2] *Regional Directorate of Primary and Secondary Education of Crete*

[3] *University of Bolognia*

[4] *Fondazione Golirreli*

[5] *University of Helsinki*

[6] *University of Bremen*

[7] *Elinogermaniki Agogi*

The goal of the CLIMADEMY Erasmus + project is to create a community of practice and network to facilitate the establishment of creative professional development techniques and programs for serving as well as ongoing professional development for teachers about climate change and its effects. A Teachers' Academy, which will be established through four hubs in different countries as well as a common virtual Climate Auditorium. The initial network will consist of, 200 trainees from around Europe who will participate in this Academy over the course of three years through online, in-person, and blended learning.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Informal Education

Poster session / 75

CERN Science Gateway –New Education Labs

Author: Julia Woithe[1]

Co-authors: Anastasia Tezari ; Charlotte Baumgart ; Panagiota Chatzidaki [2]; Patrick Thill [1]; Sascha Schmeling [1]

[1] *CERN*

[2] *Lund University (SE)*

Corresponding Author: julia.woithe@cern.ch

CERN is the world's largest particle physics laboratory. It's the home of the most powerful particle accelerator in the world, which enables scientists to study the fundamental interactions between elementary particles. CERN also offers a unique environment for learning and training. CERN Science Gateway, a brand-new science education and outreach centre that opened on 7 October 2023, offers visitors a rich and authentic out-of-school learning experience. This poster presents new lab workshops developed for CERN Science Gateway, which bring authentic STEM challenges to learners as young as 5 years.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Informal Education

Poster session / 246

Teacher professional development on properties of matter in primay education

Authors: Alessandra De Angelis[1]; Antonella Archidiacono[2]; Aycin Unal[3]; Lorenzo Santi[1]

[1] *PER Unit, University of Udine*

[2] *Scientific Liceum L. da Vinci of Treviso, Italy*

[3] *Mugla Science and Art Center, Turkey*

The interdisciplinary nature of science education often leads to a focus on observing phenomena, neglecting to take care of the epistemic aspects and the acquisition of awareness of basic methodologies. Among these aspects are the properties of matter, their measurement, and their role in physics laws. Our proposal for this study focuses on the application of a mixed model EL-CP-ES to build competence in a group of primary teachers of the properties of matter, in order to recognize their role in physics laws. The context is a teacher net, which every year organizes a professional development activity on science education.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Formal Education

Poster session / 295

Construction of flying machines as introduction to basic physics for young students

Authors: Monika Trojanowska[1]; Sylwia Orzeł[2]

Co-authors: Daniel Dziob [2]; Jolanta Rokosz [2]; Karolina Guśtak [2]; Szymon Mantlingiewicz [2]

[1] *Aviation Education Centre Kraków Airport*

[2] *Aviation Education Centre*

Who hasn't wondered how something as big as an airplane can stay in the sky? Why does a balloon float in the sky? Curiosity about the world is a natural feature for children, but the trick is not to make it disappear when we teach them scientific knowledge. During summer camps at the Aviation Education Center, we put (not only) physical knowledge into a construction scenario. Through elements of competition and fun, we tried to provide students not only with knowledge, but also with the method of inquiry through discovery and experimentation.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Non-formal Education

Poster session / 79

The effect of teaching Physics using the Flipped Classroom model on students' domains included in the Integrated Taxonomy

Author: Gergő Sipka[None]

This study examines the effect of the flipped classroom (FC) model on secondary vocational school students through the development of their domains described in the Integrated Taxonomy [1]. This research fills a gap in the Hungarian scientific community having only a few papers written on the FC model examining its effect. Three classes (72 students) participated in the research during Physics classes. This mixed method research study used pre-and post-tests, questionnaires, and quizzes, from which data was collected, processed in SPSS, and quantified with the Wilcoxon signed-rank test. The results showed improvement in each domain in all classes.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 163

Probing students' estimates of astronomical sizes and distances

Author: Willem Keppens[None]

Co-authors: Hans Van Winckel [1]; Jan Sermeus ; Mieke De Cock ; Wim Van Dooren [1]

[1] *KU Leuven*

Despite intensive educational efforts, it is generally known that many students still hold numerous astronomical misconceptions by the time they leave secondary school. While the identification of these misconceptions has been widely studied, much less research is devoted to retracing their origin. This work is motivated by the notion that many misconceptions may stem from erroneous estimates of astronomical sizes and distances. As this research is still in its early stages, several types of questions are explored for the assessment of students' estimates during two rounds of pilot interviews. The findings of these pilot studies are discussed here.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Informal Education

Poster session / 254

Results of an Active methodology proposal for learning Physics: Experimental stations in the classroom for the investigative learning of Sound concepts in the 8th grade

Author: Telma Esperança[1]

Co-authors: Maria José de ALMEIDA [2]; Paulo Gordo [2]

[1] *universidade de coimbra*

[2] *CFisUC, Department of Physics, University of Coimbra, Portugal*

This work is concerned with well-known difficulties felt by young students on dealing with Physics learning in schools. We have developed an active learning methodology aiming at the understanding of Sound by 8th grade students, mediated by the use of experimental tools in the classroom which potentiate a gradual building of successive correct cognitive structures. Aware of Physics teachers' difficulties, we purpose structured experimental activities which potentiate the curiosity and interests of young learners. The results of this learning project were tested with a sample of 359 students, divided among eight experimental'and seven control'classrooms.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 296

Developing new habits for Physics teachers through Creative Ateliers

Author: Giovanna Modugno[None]

Co-authors: Francesco Longo ; Maria Peressi ; Valentina Bologna

Inspired by the Reggio Emilia Atelier experience and embracing the DHAC (Development of Habits in Apprenticeship Community) framework, we promoted an in-service Physics teacher training program called "Creative Atelier for Physics Exercises and Problems". The program aimed to activate teachers'creativity and skills, expanding their knowledge in deconstructing and re-building from "regular"problems and exercises to the ten ISLE types for developing scientific abilities. We report the teachers'process of activating new habits, some new exercises, and problems created.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / **166**

Physical pendulum experiment and HTML5 simulation

Author: Peter Farago[None]

Co-author: Arpad Bordas

Physical pendulums are commonly used to study the dynamics of rotating systems. The aim of our study is to describe a simple physical pendulum experiment and provide an HTML5 simulation designed for investigating the experiment. In the experiment, we utilize a system consisting of a steel rod and a movable solid sphere as the pendulum. Both the experiment and simulation are intended for high school and undergraduate students.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / **86**

Development of a Multiple Choice-test on Newtonian Mechanics for the lower secondary level

Author: Kerstin Lindmaier[1]

Co-authors: Lana Ivanjek ; Martin Richard Hopf

[1] *Johannes Kepler Universität Linz*

As part of a broader project on students understanding of Newtonian mechanics, a new test-instrument on two-dimensional motion with 36 items has been developed. The instrument probes students understanding on speed, velocity, change of velocity, the relationship between force and motion and the 3rd Newton Law. The test is administered to 140 lower secondary school students aged 12-14 in Austria. Data analyses is done with the WINSTEPS software for Rasch analysis. Test development process and results will be presented on the poster.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 184

Investigating the Nature of Science with Zeno's paradox

Author: Pasquale Onorato[1]

Co-author: Marco Di Mauro [1]

[1] *University of Trento*

This study presents a sequence of activities aligned with Nature of Science (NoS) principles to engage students in scientific knowledge-building, emphasizing the empirical nature of science. Designed for an experimental physics course for future teachers, the activities explore Zeno's paradox of Achilles and the tortoise. They include experimental and theoretical analyses of phenomena like the bouncing marble, aided by infinite series. Debates on whether Zeno was a scientist prompt discussions on science as a doctrine versus a process. These perspectives are further elucidated through discussions on a reconstructed Achilles'Paradox quote from Aristotle and an excerpt from Somerville's "Umbrellaology" (1941).

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 313

Transformative Interactive Experience at Specola Margherita Hack for Enhanced Public Engagement in Astronomy

Author: Marco Citossi[None]

The Specola Margherita Hack merges cutting-edge technology with historical insight to revolutionize astronomical education and public engagement. The ground floor features an interactive, multilingual multimedia exhibit that not only chronicles the Astronomical Observatory's extensive history but also integrates immersive technologies such as a 3D-projection of the Reinfelder telescope and interactive touchscreens for digital exploration. Upstairs, a state-of-the-art 60 cm reflecting telescope provides visitors with direct, unmediated views of the cosmos, complemented by a dome-integrated projection system for interactive celestial simulations. These enhancements have significantly increased visitor engagement, establishing the observatory as a premier destination for immersive educational experiences in astronomy.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Non-formal Education

Poster session / **272**

A Computational Modelling in Secondary Physics Teaching as an Example of the Implementation of the Concept of STEM Education

Author: Oktawia Koc[None]

STEM education is a learning management approach in which students acquire the ability to integrate scientific knowledge, technology, mathematics and engineering processes. Particular attention is paid to the development of so-called "twenty-first century skills", among which ICT skills play significant role. For the needs of research, innovative classes will have been conducted, during which secondary students will meet the examples of computer-aided mathematical modelling in physics. The main purpose of the research is to prove that computational modelling based on the use of programming in Wolfram Mathematica language facilitates integrated learning and develops ICT skills.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Informal Education

Poster session / **92**

Development of a teaching concept on the subject of "sound propagation" based on a transmitter-receiver-model

Author: Tanja Lehr[None]

Co-authors: Claudia Haagen-Schützenhöfer ; Markus Obczovsky

One of the most important senses of the human body is the sense of hearing. In Austrian schools ‚hearing'and related physical concepts (sound generation and propagation) are already part of the physics curriculum in 6th grade (age 11-12). However, for this target group, evidence-based teaching concepts covering research findings on learning difficulties and student concepts are not available. Therefore, we are developing such a new teaching concept on sound propagation and hearing. After the development of the first version of this concept, we conducted teachings experiments and refined the teaching concept.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 97

Translating a Concept Inventory into English –The Case of the CCCI-442

Author: Claudia Haagen-Schützenhöfer[None]

Co-author: Thomas Schubatzky

Concept inventories are crucial for assessing students' understanding. The Climate Change Concept Inventory (CCCI-422) was developed to meet the need for a reliable assessment-tool in German for assessing the effectiveness of educational interventions and informing policy decisions in addressing this pressing issue. To make it accessible internationally, the CCCI-422 underwent a systematic translation procedure, aligning with Brislin's model. The translation involved software-generated and expert translations, followed by comparison and negotiation of differences. The English version is presented, highlighting translation challenges and seeking collaboration for validation. This translation approach of instruments aims to contribute to the comparability of research in PER.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 36

Using Mobile Apps for Physics Teaching and Learning

Author: Ana Mgeladze[1]

Co-author: Marika Kapanadze [1]

[1] *Ilia State University*

Corresponding Author: ana.mgeladze.2@iliauni.edu.ge

Technological, Pedagogical Content Knowledge (TPACK) model is used as a conceptual framework to define knowledge domains that are required for teachers to successfully incorporate technology in the classroom. Smartphones represent the most accessible resource among the existing technological tools in Georgian schools, surpassing other gadgets, that are widely used by both teachers and students. Two mobile applications are selected for integration into the training module for physics teachers. The findings of presented study offer an opportunity to integrate modern technologies in teacher training programs. Recommendations will be elaborated to improve the physics curriculum, teacher training, and classroom activities.

How would you like to present your contribution?:

Hybrid from my own country (early in the conference day, best for Asia, Australia)

Target education level:

Secondary

Category:

Formal Education

Poster session / 273

A simplified approach with FFT and smartphone in high school physics

Author: Eugenio Tufino[1]

Co-authors: Luigi Gratton [1]; Stefano Oss [1]

[1] *University of Trento, Physics department*

This communication explores the application of Fast Fourier Transform (FFT) utilizing smartphones and Jupyter Notebooks to introduce students to the amplitude spectrum as a graphical representation. Through targeted activities, students engage with real-world applications, analyzing sound signals and exploring sound properties in an accessible manner. We introduce our methodology and the materials created for this educational initiative. Additionally, we examine the feasibility and effectiveness of our intervention based on feedback from questionnaires administered to students and outcomes of a test specifically designed according to our learning goals.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 189

Early findings on how upper-secondary students use chatbots in learning science

Authors: Marie Snětinová[1]; Petr Kácovský[1]; Lydia Cehláková[1]; Jana Legerská[2]; Jitka Houfková[1]; Tomáš Kopřiva[1]; Jana Marounová[1]; Jaroslav Nauš[1]

[1] *Department of Physics Education, Faculty of Mathematics and Physics, Charles University, Prague*

[2] *Department of Physics Education, Faculty od Mathematics and Physics, Charles University, Prague*

Corresponding Author: marie.snetinova@matfyz.cuni.cz

The current development of artificial intelligence is driving transformations of various sectors, including education. We focus on examining the use of chatbots in science education: especially, what proportion of students have experience with using chatbots in learning science, and what activities they use chatbots for. The survey was conducted with upper-secondary students (N = 1175) via an online questionnaire. Our research highlights that the vast majority of students incorporate chatbots into both their daily lives and school context, primarily when seeking information on unfamiliar topics. This underscores the need for educators to take this trend into account in their teaching.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / **188**

An Italian university network for the professional development of teachers in physics

Author: Marisa Michelini[None]

Teacher professional development (TPD) is a research topic that offers differentiated theoretical frameworks in the literature, giving rise to several evidence-based findings from specific research. Less common is the study of how networks of differentiated competence can produce improvements for actions on TPD. This contribution offers the experience and problems identified by an Italian network of universities cooperating for TPD within the PLS project. This contribution is offered in the context of the workshop #245.

How would you like to present your contribution?:

Hybrid from my own country (later in the conference day, best for Americas)

Target education level:

Secondary

Category:

Formal Education

Poster session / **276**

Enhancing Secondary School Physics Teachers' Understanding of Quantum Concepts and Pedagogical Strategies Through Professional Learning Networks

Author: Kirsten Stadermann[None]

This exploratory study addresses the effectiveness of professional learning networks (PLNs) in improving high school physics teachers' understanding and teaching of quantum physics (QP). The research focuses on how participation in a quantum physics-focused PLN can increase teachers' content knowledge (CK) and pedagogical content knowledge (PCK), which ultimately enhances their teaching self-efficacy. Preliminary results indicate that participation in PLNs leads to significant gains in teachers' CK and PCK, suggesting a promising path for professional development in physics education.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 187

Lab2Go: a project for fostering interest in laboratory in different contexts

Author: Vera Montalbano[1]

[1] *University of Siena*

Corresponding Author: montalbano@unisi.it

The physics laboratory is a very engaging teaching tool and allows to clarify fundamental conceptual issues of physics. However, little time is often dedicated to it. Problems, like the lack of maintenance of the instruments or the limited equipment available, could render it difficult. The LAb2Go project propose support in an optional laboratory. The activities carried out as part of this project in three schools will be compared, highlighting the need for context analysis to implement truly effective activities both from the point of view of the primary objective, i.e. restoring tools and experiences, both for educational effectiveness in physics.

How would you like to present your contribution?:

Hybrid from my own country (early in the conference day, best for Asia, Australia)

Target education level:

Secondary

Category:

Non-formal Education

Poster session / 191

Instructing high school students in a teaching-learning sequence on the physical basis of the greenhouse effect: preliminary results

Author: Stefano Toffaletti[1]

Co-authors: Marco Di Mauro [2]; Alessandro Salmoiraghi ; Camilla Fiorello ; Pasquale Onorato [2]; Stefano Oss [2]

[1] *Physical Science Communication Laboratory, Department of Physics, University of Trento, Via Sommarive, 38050 Povo (Trento), Italy*

[2] *University of Trento*

The collaboration of the University of Trento (Italy) with high schools in its province gave us the opportunity to test at that school level the teaching-learning sequence developed by our group on teaching the physical basis of the greenhouse effect.
The sequence had to be adapted to the new learning context: actions were taken both at the level of

language, content and order of topics. In particular, some experiments were presented only qualitatively, as the main objective in this context is understanding the physical phenomenon rather than developing laboratory skills. We will present the actions taken and some preliminary results.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 111

COOL IT: A Digital Game on the Greenhouse Effect for Physics Education

Authors: Ingrid Graz[1]; Raffael Lucas Maxian[None]

[1] *Johannes Kepler University*

The goal of ECOPOLIS is to develop and evaluate a physics education concept for the use of the digital learning game called Cool It. It focuses on the greenhouse effect challenging the player to remove greenhouse gases. To encourage use of Cool It the game was embedded into a teaching unit and learning success was measured using a mixed-method approach using questionnaires, interviews, and worksheets. We hope that the interactive and playful multi-media approach can convey a complex subject and lead to a deeper understanding. In this talk the game Cool It will be presented, as well as the results.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 290

Biomechanical Analysis in Rowing: Determining Pace with Autocorrelation

Authors: Armina ÇEBİ[None]; Arnisa ÇEBİ[None]; Bora UYSAL[None]; Fatma CANER[None]

Corresponding Author: fatma.caner@tededirne.k12.tr

STEM approach encourages interdisciplinary thinking while also emphasizing connections between the fields of science, technology, engineering, art, mathematics and sport. Biomechanical analysis

in rowing examines athletes' movements, muscle activity, movement of joints and energy transfer in detail, providing key insights to optimize their performance. In this study, we performed a biomechanical analysis of rowing using Phyphox for data collection and Python on Google Colab for processing. By analyzing tempo and performance with various paddles, we determined how paddle type affects rowing boat speed. The findings offer insights into optimizing rowing performance through data-driven analysis.

Target education level:

Secondary

Category:

Formal Education

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Poster session / **284**

Results of a Galilean Physics-of-motion Teaching Case Study

Author: Vincenzo Cioci[1]

[1] *Naples Section of the Italian Association for the Teaching of Physics - Liceo Scientifico "F. Sbordone" in Naples*

This paper is based on previous works [1, 2] and is an extension of my doctoral thesis [3] completed at the University of Lille under the direction of Prof. Raffaele Pisano. A comprehensive course on the Galileo's physics of motion was implemented in curricular time with particular emphasis on laboratory activities. A questionnaire was administered before and after the teaching activity held at the Liceo scientifico 'F. Sbordone' in Naples, providing important results on the effectiveness of the educational historical path and more generally on the Nature of Science (NoS) Teaching [4].

How would you like to present your contribution?:

Hybrid from my own country (later in the conference day, best for Americas)

Target education level:

Secondary

Category:

Formal Education

Poster session / **208**

Active In-Service Training on Transversal Skills: Two Pilot Cases in STEM Disciplinary Teaching

Author: Vera Montalbano[1]

Co-author: Daniela Marchini [2]

[1] *University of Siena*

[2] *Department of Life Sciences, University of Siena, Siena, Italy*

Promoting gender equality in STEM disciplinary teaching and self-assessment skills in students requires transversal competences and methodologies that are usually not included in teachers' cultural background. Based on previous experiences, we implemented, in an interdisciplinary team, two in-service training courses for teachers. In one, after introducing the topic of gender and related educational issues, teachers were invited to develop a learning path to be implemented in class in the following months. Then we analysed together the results and critical issues that emerged. In the other, a laboratory of self-assessment for students is promoted by an in-service course for STEM teachers.

How would you like to present your contribution?:

Hybrid from my own country (early in the conference day, best for Asia, Australia)

Target education level:

Secondary

Category:

Non-formal Education

Poster session / **124**

Support models for simulation-based inquiry learning of the photoelectric effect

Author: Cathy Baars[None]

This practitioner inquiry study evaluates two support models, Model Order Progression (MOP) and Concept Maps (CM), for inquiry-based learning of the photoelectric effect. The support models were evaluated on their impact on cognitive load, knowledge, retention, and scientific literacy. Results did not show a significant difference between the two models; however, the effect size showed a modest difference: MOP resulted in a smaller cognitive load, and CM showed better knowledge retention. In a follow-up study, the findings were used in combination with modeling instruction. This integrated approach offered a more effective way to support students in inquiry-based learning.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / **282**

Qualitative analysis of high school and university textbooks on thermodynamics and statistical physics

Author: Tomáš Blovský[1]

[1] *Faculty of Mathematics and Physics, Charles University, Prague*

In this research, focused on selected topics on thermodynamics and statistical physics in secondary and higher education, we aim to find out how well the basic concepts are defined in high school and university literature. Critical analysis of available textbooks and teaching materials was carried out. By examining the accessible Czech and foreign language textbooks, as well as multimedia sources (web pages, computer simulations etc.), associated with teaching thermodynamics and statistical physics at both levels, we probe the quality of the learning sources. Based on this research, new educational materials will be prepared and piloted in secondary schools and universities.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / **192**

Integrating sustainability into secondary school teacher training: a multidisciplinary approach to promote active learning and behavioural engagement

Author: Camilla Fiorello[None]

Co-authors: Alessandro Salmoiraghi ; Marco Di Mauro [1]; Pasquale Onorato [1]; Stefano Oss [1]; Stefano Toffaletti [2]

[1] *University of Trento*

[2] *Physical Science Communication Laboratory, Department of Physics, University of Trento, Via Sommarive, 38050 Povo (Trento), Italy*

This study uses a multidisciplinary approach to train secondary school teachers on sustainability to promote active learning and behavioural engagement. The teacher training course seeks to improve teachers' understanding of the complexity of sustainability through various topics, including climate, energy considerations, economic and legal aspects, and socio-anthropological perspectives. The aim is to enable teachers to have a broader view of sustainability that can lead to a broadening of teaching practices. Physics provides a solid framework for teachers to broaden and integrate their view of sustainability. The course focuses on enhancing the psychological factors identified as enablers in climate psychology.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **325**

Watts up?: In which creative ways can you collect assessment points?

Author: Katleen Maris[None]

Corresponding Author: kmaris@skynet.be

The overall question that led to this inquiry was: how can I make all of my students feel more motivated to learn physics? In this investigation, I try to find the answer to the sub-question, "How can I increase the power, Watts, of my students so that they feel more like working for physics?" Watts up! To increase this motivation, the use of simple digital tools that playfully test students has been tested.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 314

Conceptualisation and quantitative study of aesthetic and affective Perception of Pictures in Physics Education

Authors: Raimund Girwidz[1]; Tatjana Zähringer[None]

[1] *Ludwig-Maximilians-Universität München*

Corresponding Authors: girwidz@physik.uni-muenchen.de, tatjana.lamparter@physik.uni-muenchen.de

Visualizations in physics education attract attention, fascinate viewers, and motivate engagement with the content. Research has linked visualization attributes to influence learning, but questions persist about how aesthetic visuals affect learning. Understanding student perceptions of picture aesthetics is essential, before investigating this further. Delving into theory of art and design, we selected criteria to choose eight pictures; four considered aesthetic. We assessed the perception of the pictures using a newly developed questionnaire. Results showed the chosen aesthetic pictures were more appealing. A short interview confirmed these findings, confirming that the selected criteria are effective for choosing aesthetic pictures.

Target education level:

Secondary

Category:

Formal Education

How would you like to present your contribution?:

Hybrid from my own country (early in the conference day, best for Asia, Australia)

Oral presentations / 257

The Quantum for All Project: Professional Development Model and Teacher Outcomes

Author: Ramon Lopez[1]

Co-author: Karen Matsler [1]

[1] *UT Arlington*

The Quantum for All project has developed instructional materials and a professional development program to expand Quantum Information Science education in precollege education. In this presentation, we discuss the design of the professional development plan and the development of the materials by the Leadership Team. We then discuss the workshops for teachers to learn and utilize this content. We will examine growth in teacher knowledge and confidence, and we also examine the variation of these things across content domains as represented by the instructional modules.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 52

Introduction of an IBT approach for nuclear physics education in high schools: a case study

Authors: Marina Carpineti[1]; Paolo Teruzzi[1]; nicola ludwig[1]

[1] *Università degli Studi di Milano*

Corresponding Author: paolo.teruzzi@unimi.it

An educational experiment on nuclear physics topics developed in fourth and fifth grades of an Italian scientific high school is presented. The ten-hour nuclear physics (NP) program was carried out following an innovative energy (IE) related path in two groups of penultimate year classes formed by students selected on a voluntary basis. The first group followed a traditional teaching approach while the second followed an IE approach. The teaching and satisfaction results and limitations of the experiment are discussed. The results of the experimentation were later used to redesign and propose a similar course to a fifth grade class.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **167**

Exploring the non-linear viscoelastic properties of a mass-rubber band oscillator

Author: Onofrio Rosario Battaglia[None]

Co-authors: Claudio Fazio [1]; Giulia Termini ; Aurelio Agliolo Gallitto [2]

[1] *Università degli Studi di Palermo*

[2] *Dipartimento di Fisica e Chimica –Emilio Segrè, University of Palermo, Palermo, Italy*

Corresponding Author: onofriorosario.battaglia@unipa.it

This contribution outlines an experimental procedure that can be executed via smartphones in order to analyse the oscillations of a mass-loaded damped oscillator composed of an elastic rubber loop. By utilising this system, data regarding the viscoelastic characteristics of the rubber material can be acquired. The analysis is conducted by varying the mass. A non-linear model for the elastic force was determined to be necessary in order to account for the experimental data. This experiment gives students accurate experimental data and challenges them to evaluate models' capacity to explain observed behaviour.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / **33**

Air-source heat pumps in the secondary physics laboratory

Authors: Daniel Cottle[1]; Robert Campbell[2]

[1] *University of Birmingham*

[2] *University of Birmingham School*

Decarbonisation of home heating in England is accelerating through the phasing out of gas boilers and the introduction of air-source heat pumps. We argue that the physics secondary school curriculum in England therefore needs to change to include understanding of the thermodynamic principles of operation of air-source heat pumps. We present details of a classroom activity to demonstrate the efficiency of air-source heat pumps compared to other forms of home heating.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 120

Validation of a Science Adapted Identity Model

Author: Lisa-Marie Christ[None]

Co-authors: Olaf Krey ; Frederik Bub ; Thorid Rabe

Corresponding Author: lisamarie.christ@uni-a.de

The research project aims to validate an adapted identity model that combines a socio-psychological and a sociological concept of identity. The synthesis of the two perspectives offers a comprehensive insight into learners'engagement with and their positioning towards science. The adapted identity model proposes four multidirectional identity dimensions to analyse the science identity of learners, namely autobiographical, discoursal, authorial, and sociocultural available identity. Narrative interviews with learners in their first two years in science education (with a focus on physics and chemistry) are used to validate the adapted identity model.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 141

The first results from the TIMSS Advanced 1995 specialized physics test repeated among Czech gymnasium students in 2023

Authors: Petra Pschotnerová[1]; Dana Mandíková[1]

[1] *Charles University*

Corresponding Author: petra.pschotnerova@matfyz.cuni.cz

After almost 30 years, we repeatedly administered the TIMSS Advanced 1995 specialized physics test to final-year students of gymnasiums in the Czech Republic. In 1995, 819 students from 90 gymnasiums participated; in 2023, the sample consisted of 1602 students from 73 gymnasiums. We compared the overall mean physics achievement, the mean achievement of males and females, and the mean achievement in the physics content areas between 1995 and 2023. We analysed changes in individual answer categories for open-ended items. A significant decrease in the mean achievement of the students in the physics test compared to 1995 was observed.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 118

The Influence of Using an Arduino-supported Project Book on the Development of Knowledge and Attitude towards Physics

Author: Schnider Dorottya[None]

Co-author: Mihály Hömöstrei

Corresponding Author: schniderd@f.fazekas.hu

In our study, we offer secondary school physics teachers an insight into the effective application of Arduino-based classroom measurements for teaching kinematics. We introduce our Arduino-supported workbook, which contains Arduino-based kinematics measurements with the use of an ultrasonic wave sensor. The aim of the tasks is to develop students'knowledge and professional skills, e.g.: data processing, data analysis, interpretation, graphical representation, etc. In our study, we investigated the role of Arduino measurement tasks in knowledge, competence, and attitude development of 7th grader students. The results indicate the positive effect of well-coordinated, practice-oriented, and creative activities in the classroom.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 319

How the implementation of the IBL method in the second grade of high school can help my students to overcame the fear of experimenting on physics lessons

Author: Joanna Biel-Kiepura[1]

[1] *Zespół Szkół nr 6 we Wrocławiu*

Students with special educational needs in secondary schools often find it difficult to carry out actions during experiments in physics lessons. These difficulties are sometimes related to a lack of manual dexterity, a reluctance to touch objects, or a feeling of alienation during the pandemonium. To demonstrate the use of the IBL method as a support for overcoming anxiety when carrying out experiments.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **177**

Study on the difficulties in learning fundamental concepts of thermodynamics in the initial training of physics teachers: the case of analogical scientific reasoning

Author: TARCILO TORRES VALOIS[None]

Co-authors: Bibiana Maria Cuervo Montoya ; Calvo Victor [1]; Laura Álvarez [1]; María José Ruiz [1]; Sebastián Moreno [1]; Valencia Katerin [1]

[1] *Universidad de Antioquia*

Corresponding Authors: laura.alvarezr@udea.edu.co, maria.ruiz11@udea.edu.co, sebastian.morenop@udea.edu.co, katerin.valencia@udea.edu.co, tarcilo.torres@udea.edu.co, bibiana.cuervo@udea.edu.co, victor.calvo@udea.edu.co

An exploratory study on urban thermodynamics with 24 participants compared their responses in interviews with those of an artificial intelligence. Results showed varied responses, with some moderate agreement. The study suggests interdisciplinary educational strategies are crucial for addressing urban thermal challenges, promoting deeper understanding and concrete actions in urban environments.

How would you like to present your contribution?:

Hybrid from my own country (later in the conference day, best for Americas)

Target education level:

University

Category:

Formal Education

Oral presentations / **144**

The right way to introduce complex numbers in damped harmonic oscillators

Author: James Freericks[None]

Co-authors: Jason Tran [1]; Leanne Doughty [1]

[1] *Georgetown University*

In 1930, Born and Jordan wrote a quantum mechanics textbook. In that work, they used a strategy to convert the harmonic oscillator equations of motion into two uncoupled first-order equations. In classical mechanics, this mapping explicitly introduces complex numbers into the motion of a harmonic oscillator and directly shows how to solve for the position and momentum observables. I

will explain how this mapping works and show how to demystify complex numbers use in damped-driven harmonic oscillators. As an added bonus, this approach also shows how energy varies with time and makes a strong connection to quantum mechanics.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 297

How to evaluate students' answers and build on them? –the workshop for physics teachers

Authors: Danijela Dodlek[1]; Eugenia Etkina[2]; Gorazd Planinsic[3]

[1] *Josip Juraj Strossmayer University of Osijek, Department of Physics*

[2] *Rutgers University, 10 Seminary Place, New Brunswick, NJ 08901, USA*

[3] *Faculty of Mathematics and Physics, University of Ljubljana*

We present the workshop we developed and conducted with the physics teachers using the findings of our previous study regarding the teachers'interpretation of and responses to students'explanations. We explain how the goals of the workshops stemmed from the research findings, present the details of the workshop procedure and participants'activities and discuss how the outcomes of the workshop relate to the research findings.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 180

Latvian students' perceptions of experimental physics: insights from E-CLASS survey

Author: Jelena Kosmaca[1]

Co-authors: Girts Barinovs [1]; Guntars Kitenbergs [1]; Ilva Cinite [1]; Ilva Cinīte [1]

[1] *University of Latvia*

Our ambition is to improve physics courses at the University of Latvia by transforming the lab works, to focus on practical skills and engage students in experiments. To assess Latvian students' perceptions of experimental physics and monitor changes during the transformation, we utilised the Colorado Learning Attitudes about Science Survey (E-CLASS) instrument with groups of bachelor and master students. Preliminary findings revealed the baseline of students' attitudes and demonstrate the diverse impact lab instructions can have on them. Characteristic differences for group scores emerged in individual survey questions, highlighting the importance of instructional design for achieving the intended learning goals.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 275

Absolute zero: An upper-secondary acoustic levitation lab

Author: Andreas Johansson[1]

Co-authors: Sebastian Kilde Löfgren [1]; Jonas Enger [1]

[1] *Department of Physics, University of Gothenburg*

The concept of sound waves is central to our everyday experience and part of upper-secondary school physics. Acoustic levitation represents an application of standing-wave phenomena, which has seen a surge in popularity due to the introduction of cost-effective ultrasonic speakers. However, acoustic levitation by affordable speakers remains absent from most upper-secondary physics education. Therefore, we developed LeviLab; a low-cost, user-friendly, and easily reproducible acoustic levitation experiment to measure the wavelength and speed of sound. This study proposes using LeviLab to integrate acoustic levitation into the classroom setting to measure absolute zero.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 130

Praxis of designing an inclusive science curriculum: acoustics within teacher education for and with Peasants and Deaf persons

Author: Danila Ribeiro Gomes[1]

Co-authors: Ana Karine Vieira Costa [2]; Cristiano Mattos [3]

[1] *Universidade Federal de Viçosa, Programa de Pós-graduação Interunidades em Ensino de Ciências da Universidade de São Paulo*

[2] *Programa de Pós-graduação Interunidades em Ensino de Ciências da Universidade de São Paulo*

[3] *Universidade de São Paulo*

The growing multicultural and identity diversity of students at the university worldwide requires changing curricula. Our case study aimed to identify inclusive criteria that have emerged in a praxis of designing an Acoustics micro-curriculum carried out in a teacher training course with Peasant students and a Deaf student. Our theoretical-methodological framework comprised the Cultural-Historical Activity Theory, van den Akker's curriculum model and Paulo Freire's pedagogy. We developed a protocol to describe the textbook produced within that praxis. Our findings were five inclusive criteria that have impacted the physics teacher training within the scope of the Acoustics micro-curriculum.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 117

Assessing students' understanding of computational modelling in physics

Author: Roeland Boot[1]

Co-authors: Kim Krijtenburg-Lewerissa [2]; Wouter Van Joolingen [3]

[1] *Physics teacher and PhD candidate Utrecht University*

[2] *Assistent Professor and University lecturer in physics education at the Freudenthal Institute*

[3] *Professor of didactics of mathematics and natural sciences at the Freudenthal Institute*

In secondary physics education, integrating computer modelling offers diverse benefits for students, such as enhancing realism in understanding physics principles, familiarization with scientific inquiry methods and exploration of complex phenomena. Assessing metamodelling competences is crucial for effective implementation. We present an adaptation of the existing Framework for Modelling Competence (FMC) towards physics computational modelling. A interview study with Dutch pre-university students indicates strengths in the aspects Nature, Purpose and Testing but gaps in the aspects Multiple and Changing. Further refinement of competences is suggested for optimal utilization of the framework.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 88

Students change in attitudes towards group work: A case study of the ISLE-based reform

Author: Nastja Mahne[None]

Co-authors: Gorazd Planinsic [1]; Sergej Faletic

[1] *Faculty of Mathematics and Physics, University of Ljubljana*

Corresponding Author: nastja.mahne@fmf.uni-lj.si

We examine students' attitudes to group work in physics courses with the Investigative Science Learning Environment (ISLE) approach. ISLE highlights the importance of group work. Students collaborate in lectures, recitations, and laboratories. We aim to answer the following questions: How have students' attitudes towards group work changed during the course? How is this change influenced by their previous experiences? What role did ISLE play in the development of students' attitudes?
We examine students' attitudes using semi-structured interviews. For triangulation we use responses to CLASS and E-CLASS questionnaires, attendance records, their submission and resubmission of lab reports, and success on exams.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 329

Quantum Light Dimmer

Authors: Dobromiła Szczepaniak[1]; Maciej Schydlo[None]; Piotr Ludwikowski[None]; Łukasz Spyrka[None]

[1] *Akademickie Liceum Ogólnokształcące Politechniki Wrocławskiej*

Corresponding Authors: piotrek.ludwikowski@gmail.com, dobnosz@gmail.com

The absorption of sodium lamp light by the flame spiced with table salt is a cause of the shadow cast by the flame. When the magnetic field is applied, the shadow fades a little due to the Zeeman effect. The experiment and its analysis are of didactical interest because they allow students to observe several aspects of quantum theory and the application of interferometry in an intriguing effect.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 186

DPFS: Italian national survey on the perception of scientific practice among primary school children

Authors: Giacomo Bozzo[1]; Onofrio Rosario Battaglia[2]; Claudio Fazio[2]; Alice Lemmo[3]; Marisa Michelini[4]; Maria Assunta Zanetti[5]; Peppino Sapia[6]

[1] *University of Calabria –Department of Mathematics and Computer Science - AgoràLAB: Laboratory for Science Communication*

[2] *University of Palermo –Department of Physics and Chemistry "E. Segrè"*

[3] *University of l' Aquila –Department of Engineering and Information Sciences and Mathematics - GEO: Italian Interuniversity Research Center for the Study of Youth Condition, Educational Institutions and Guidance*

[4] *University of Udine –Department of Physics - GEO: Italian Interuniversity Research Center for the Study of Youth Condition, Educational Institutions and Guidance*

[5] *University of Pavia –Department of Neurological and Behavioural Sciences - GEO: Italian Interuniversity Research Center for the Study of Youth Condition, Educational Institutions and Guidance*

[6] *University of Calabria –Department of Mathematics and Computer Science - AgoràLAB: Laboratory for Science Communication - GEO: Italian Interuniversity Research Center for the Study of Youth Condition, Educational Institutions and Guidance*

In the evolving modern society, technological advancements bring opportunities and challenges. Scientific Literacy is essential for understanding and navigating these changes, fostering responsible citizenship. The perception of science shapes social attitudes, especially among young students, impacting their future choices. Concerns about declining interest in scientific careers emphasize the importance of understanding how school children perceive scientists. AgoràLAB laboratory, in collaboration with GEO research centre, conducted a study using the "Draw a Person Doing Science" task to explore children's perceptions. Preliminary findings from the analysis of 1100 drawings are presented and possible future Machine Learning applications in this research are discussed.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Early Science/Primary

Category:

Formal Education

Oral presentations / 1

Network analysis to discover and characterise student responses to a conceptual survey about refraction

Author: Jesper Bruun[1]

Co-authors: Cedric Linder ; Burkhard Priemer [2]

[1] *University of Copenhagen, Department of Science Education*

[2] *Humboldt-Universität zu Berlin*

Students have been shown to make use of heuristics that may or may not be aligned with physics, when responding to conceptual tasks. This study analyses student responses (N=1368) to a conceptual survey about refraction. We use network analysis to identify 33 groups of similar responding students. We couple groups' responses to previously identified heuristics, and compare these to contextual data: Course, university, country, and physics enrolment. We find that groups show differential and nuanced patterns with regards to both responses and contextual data. This study argues that teaching of refraction should take these heterogeneities into account as possible outcomes.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / **274**

Analysis of students' eye movements during solving multiple-choice scientific literacy test

Author: Martina Kekule[None]

Co-author: Alzbeta Krejci

Our aim is to show the possibility of using eye tracking to assess some aspects of the validity of multiple-choice tests. Specifically, we focus on nine tasks with textual and graphical representations from the TOSLS science literacy test. Twenty-three high and undergraduate school students participated in the study. We can assess validity based on quantitative analysis (e.g., the time students take to solve a task, the time they spend on an alternative or a stem, etc.). We can also assess validity based on qualitative analysis of gaze plots, for example we can identify distracting graphical elements, difficult or illegible words.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / **122**

Qualitative analysis of students' learning processes emerging from the trialling of a physics teaching/learning sequence

Author: Giulia Termini[None]

Co-authors: Onofrio Rosario Battaglia ; Giusy Giarratano ; Ilaria Grazia ; Claudio Fazio [1]

[1] *Università degli Studi di Palermo*

Corresponding Author: giulia.termini01@unipa.it

In this paper, we present some general aspects of two teaching-learning sequences (TLSs) that target high school students' learning in the field of surface phenomena. After introducing TLSs' theoretical framework and pedagogical approaches, we provide a research-based conceptual scheme of what we mean by "improvement of students' learning". Then, we discuss the implementation of a thematic-like analysis of qualitative data collected during the TLSs' trialling, and, after analyzing some specific aspects of learning as they emerge from qualitative data, we report some results and discuss how to study the advancement of student learning, based on the conceptual scheme provided.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 261

The Quantum for All Project: Student Outcomes and Connections to Teacher Professional Development

Author: Karen Matsler[1]

Co-author: Ramon Lopez [1]

[1] *UT Arlington*

The Quantum for All project is designed to expand Quantum Information Science education in precollege education. The professional development model includes an opportunity for teachers to learn QIS and then teach a summer camp. In this presentation, we will examine growth in student knowledge and confidence in the QIS, as well as attitudes the students have around the topics and careers in QIS. We will also correlate these findings with teacher content knowledge and confidence for the various topics, since some topics were initially unfamiliar to the teachers.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 215

A department-wide study on the development of students' attitudes toward experimental physics: setting the groundwork for innovation

Author: Marta Carli[1]

Co-author: Davide Caruso [1]

[1] *Department of Physics and Astronomy, University of Padua*

Corresponding Author: marta.carli.1@unipd.it

As part of a department-wide effort to enhance instructional laboratories, we are implementing the E-CLASS survey across undergraduate and advanced laboratory courses in Physics and Engineering programs at our institution. Our goal is to understand the current landscape of our laboratories in terms of students' attitudes towards experimental physics and to identify differences among student populations. Preliminary data from a subset of courses offer promising insights, which will form the ground for evidence-based innovations. The study contributes to the emerging research on the innovation of university-level laboratories in the European context.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 116

An oscillating Cartesian diver to study pressure in fluids

Author: Marina Carpineti[1]

Co-authors: Claudia Volpari [2]; Fabrizio Croccolo [3]; Irene Spongano [4]; Alberto Vailati [4]

[1] *Dipartimento di Fisica "Aldo Pontremoli" - Università degli Studi di Milano*

[2] *Liceo Artistico Statale di Brera,*

[3] *Universite de Pau et des Pays de l'Adour*

[4] *Dipartimento di Fisica Aldo Pontremoli, Università degli Studi di Milano, I-20133 Milano, Italy*

Corresponding Author: marina.carpineti@unimi.it

We suggest a modification to the classical Cartesian diver experiment, wherein the diver operates within a fluid with density stratification rather than uniform density. Unlike the conventional setup, under a given external pressure, the diver achieves a stable equilibrium at a specific depth where its density matches that of the surrounding fluid. By adjusting the applied pressure, its density changes and it moves towards a new stable equilibrium at a different depth. When subjected to a sudden pressure pulse, the diver density changes and it starts oscillating driven by a restoring force with a frequency dependent on the density gradient.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 170

Exploring the Relationships between Physics Identity and Endorsement of Stereotyped views of Physics of STEM Undergraduate Students

Authors: Silvia Galano[1]; Antonella Liccardo[1]; Italo Testa[2]

[1] *Department of Physics "E. Pancini",*

[2] *University Federico II Naples*

This study aims at investigating the relationship between physics identity and stereotyped views of physics in a sample of N = 386 students enrolled in three undergraduate courses –physics, biology/biotechnology, computer science. Through hierarchical cluster analysis and a 2-way analysis of variance we found that students with higher physics identity had significantly more stereotyped views of physics. We also found that female students with higher physics identity had significantly more stereotyped views of physics than female students with lower physics identity. Our study suggests that identification with physics may be biased by endorsement of stereotyped views about physics.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Workshop / 250

Exploring Thermoelectric Phenomena by the method of Blended Learning

Authors: Marian Kires[1]; Antonia Juhasova[2]

[1] *Institute of Physics Faculty of Science UPJS in Košice, Slovakia*

[2] *Faculty of Science, Pavol Jozef Safarik University in Kosice*

Abstract. Blended learning combines online learning in guided home self-study with active student inquiry in the school's learning lab. During the workshop, the teacher will alternately be in the position of a student trying to understand the physical nature of thermoelectric phenomena but

also in the position of a teacher discovering the supporting elements of flipped learning and habitat rotation in blended learning. Peltier cell stations will be available to participants through different activities. At the end of the workshop, participants will use personal experience to evaluate the suitability of blended learning for active student physics learning.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Workshop / 327

Outer space in the classroom···–how to introduce astronomical phenomena in physics lessons?

Author: Malgorzata Szymura[1]

[1] *Zespół Szkół w Czerwionce-Leszczynach*

Corresponding Author: malgorzata.szymura@smcebi.edu.pl

Can one block give different shadows? When do the solar and lunar eclipses occur? Why do we see only one side of the Moon? How can we find distant planetary systems? These are sample research problems that will be posed during the workshops. We will solve them by building a model of a given phenomenon. We will use simple materials (modeling physical phenomena) and a smartphone or tablet.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / 292

DIY Wind tunnel. From Simple Tools to Inspirative Physics Education.

Author: Szymon Matlingiewicz[1]

Co-authors: Daniel Dziob [1]; Hanna Kościelny [1]

[1] *Aviation Education Centre Krakow Airport*

The present didactic strategy generates in students a relationship between a topic of their interest such as aviation and the physical concepts treated in the field of aerodynamics, specifically Bernoulli's law. Intellectual skills such as asking questions, formulating and contrasting hypotheses will be stimulated in students, which will help in the learning process. The project method encourages young people to make observations, asking questions, collecting, analyzing and interpreting data, and also explaining results. The youth conducted experiments using a wind tunnel, reaching conclusions that allowed them to explain how the wing profile affects the lift force in an airplane.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Non-formal Education

Poster session / 138

Connecting with quantum: Examining the educational value of the Bohr atomic model using embodied cognition and variation theory

Author: Sebastian Kilde Löfgren[1]

Co-author: Magdalena Kersting

[1] *Department of Physics, University of Gothenburg*

Corresponding Author: sebastian.kilde.lofgren@gu.se

Teaching quantum physics requires teachers to be mindful of how students connect bodily experiences with abstract models. However, the abstract nature of the quantum realm implies a lack of well-functioning real-world analogies. In the current study, we examine the prominent Bohr atomic model and its presence in educational materials through the joint lens of embodied cognition and variation theory. Together, these two theoretical perspectives open up new ways of seeing educational values and pitfalls in the use of the Bohr atomic model. Finally, this approach can be used to make suggestions on designing teaching sequences and materials.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Poster session / 25

Comparing Alternative and Traditional Certification Pathways for Physics Teachers: What Sets Them Apart?

Author: Armin Lässer[1]

Co-authors: Thomas Schubatzky [1]; Christoph Kulgemeyer [2]

[1] *University of Innsbruck*

[2] *University of Bremen*

Teacher quality significantly impacts student learning outcomes in physics. While traditional teacher education programs emphasize the development of professional competencies, alternative pathways, like the "Quereinstieg"in Austria and Germany, are increasingly common due to teacher shortages. Surprisingly, existing research suggests comparable teaching quality between traditionally and alternatively qualified teachers. However, methodological limitations challenge the validity of these findings. Addressing this gap, our study examines differences in professional knowledge and action-related skills between teacher candidates, traditionally and alternatively qualified teachers in Austria, focusing on physics. We especially anticipate differences in explaining and reflection skills of traditionally and alternatively qualified teachers.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Workshop / 28

"Tutorials in Climate Change": Teaching scientific concepts underlying climate change

Author: Sarah Wildbichler[None]

Co-authors: Lana Ivanjek ; Magdalena Micoloi ; Mieke De Cock ; Rainer Wackermann ; Thomas Schubatzky

Amid global uncertainties, climate change education is essential to empower students. In this workshop, we introduce Tutorials in Climate Change, designed to enhance conceptual understanding in the context of climate change through practical problem-solving and addressing prevalent misconceptions. Additionally, the tutorials incorporate concept cartoons and an anchored instruction approach and focus on students'reasoning. The target group are upper secondary students and future teachers. Results from an evaluation with future teachers indicate a substantial positive development in their conceptual understanding. In the workshop, tutorials and background information will be provided and implementation scenarios will be addressed.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Workshop / 46

Physics Cards Games - What's New? From "Newton's Laws"to the challenges identified in a large-scale implementation

Author: Smadar Levy[None]

Co-authors: Edit Yerushalmi [1]; Kana Ofir [2]

[1] *Weizmann institute*

[2] *Weizmann Institute of Science*

This workshop will consist of: a) a hands-on experience with the Newton's Laws game, following the Phys-Cards design principles: a summative activity to help students organize what they have learned and connect externally different scenarios with the underlying physics principles (similar to the "Circular Motion"game presented at GIREP 2023); b) a "bird's eye"view: results covering three years' experience with four Phys-Cards games implemented in a national network of Professional Learning Communities (PLCs) for high school physics teachers (˜300 teachers). We will discuss the teachers' perspectives on the benefits and challenges involved in classrooms implementation.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Workshop / 140

Methods for addressing strengths and weaknesses of the rubber sheet analogy

Author: Shachar Boublil[1]

Co-author: David Blair [1]

[1] *University of Western of Australia*

Designing instruction to make students aware of the rubber sheet analogy's strengths and weaknesses is crucial for fostering discussions about general relativity, gravity, and our solar system, as well as using models to visualise conceptually abstract ideas. This workshop aims to address essential approaches that aid in understanding the rubber sheet analogy's strengths and weaknesses, as identified (1,2). We will introduce hands-on activities utilising the rubber sheet analogy, involving participants in practical learning methods and showcasing assessment strategies.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Discussion workshop / 139

Teaching and learning quantum entanglement

Authors: Gesche Pospiech[None]; Marisa Michelini[None]; Sergej Faletic[None]

Corresponding Authors: gesche.pospiech@tu-dresden.de, marisa.michelini@uniud.it, sergej.faletic@fmf.uni-lj.si

At the GIREP 2023 conference, the GIREP thematic group "Teaching and learning in quantum physics" has organised a discussion workshop on quantum entanglement. Several findings emerged from the discussion, and several further questions were opened. In this discussion workshop we propose a series of focused questions that will expand on the topics discussed in 2023 and suggest teaching/learning ways. The organisers will invite interested participants to prepare their position on the questions and present them in the discussion. The goal of the discussion will be to provide a community-based position paper on the questions discussed.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Workshop / 214

Formative approach in physics education

Author: Věra Koudelková[None]

The workshop will offer participants the opportunity to familiarize themselves with several activities that support the formative approach in physics education. Drawing from the author's experience, both in working with teachers and in teaching at the secondary school level, the workshop aims to provide practical insights and tools for integrating formative methods into physics instruction.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Poster session / **301**

Development of critical thinking in physics education

Author: Tereza Hrouzková[None]

Co-authors: David Smrcka ; Lukáš Richterek [1]; Roman Kubínek [2]; Jan Říha [3]

[1] *Faculty of Science, Palacký University Olomouc*

[2] *Palacký University Olomouc*

[3] *Palacky University in Olomouc, Faculty of Science*

These days we have unlimited access to an overabundance of information. Some of it is not true or not based on scientific knowledge. Therefore, we should be developing the critical thinking skills of students. We need to teach them how to verify information, recognize scientifically correct information and ask questions or draw conclusions appropriately. This contribution presents an initial mapping of the level of critical thinking in university students and grammar school students. Methods for developing critical thinking were used in physics classes during one year in a selected grammar school. Consequently, we observed the changes in students' critical thinking.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Poster session / **157**

Development of an Integrated STEM Teacher Identity for Climate Education: The STEM-id project

Author: Emily Michailidi[1]

Co-authors: Chara Bitsaki [1]; Eleni Botzaki [1]; Athanasia Kokolaki [1]; Giorgos Peikos [1]; Ioannis Metaxas [1]; Dimitris Stavrou [1]; Kyriaki Dimitriadi [2]; Giannis Sgouros [2]; Kalliopi Giannakoudaki [3]; Petros Papadakis [4]; Michalis Kalatzantonakis [5]; Manolis Chairetis [5]

[1] *University of Crete*

[2] *Directorate of Secondary Education of Rethymnon*

[3] *Directorate of Secondary Education of Heraklion*

[4] *Directorate of Secondary Education of Lasithi*

[5] *Directorate of Primary Education of Chania*

The STEM-id project responds to the critical need for an integrated STEM teaching approach in the wake of accelerating climate change. In a first phase eight qualified science teachers (4 physics teachers and 4 primary teachers) collaborate with science education and climate science researchers to create integrated STEM modules on climate change. In a second phase, 24 in-service teachers will use these materials with the support of mentors to promote STEM teacher identity through group mentoring. STEM-id aims to provide insights into effective contexts and experiences for STEM teaching identity development, focusing on climate education.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Poster session / 31

"Shining lighthouse in the sea of calculus, geometry, and theoretical mechanics": The seminar introducing pre-service teachers to their future profession

Author: Irena Dvořáková[1]

Co-author: Petr Kácovský [2]

[1] *Charles University, Faculty of Mathematics and Physics, Prague*

[2] *Department of Physics Education, Faculty of Mathematics and Physics, Charles University, Prague, Czech Republic*

The Physics Teaching Seminar introduced in the second year of undergraduate studies, serves as an important component in preparing pre-service physics teachers for their future profession. It provides students with early insights into the diverse aspects of teaching, engaging them in discussions on various facets of the „teaching craft". We build the seminar upon both our and students' experience, aiming for future teachers to think about their profession independently and critically. The aim of the poster presentation is to acquaint interested parties with the course design, its strengths, and potential risks.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / 302

Level of scientific reasoning of university students and grammar school pupils

Author: David Smrcka[None]

Co-authors: Tereza Hrouzková ; Lukáš Richterek [1]; Jan Říha [2]

[1] *Faculty of Science, Palacký University Olomouc*

[2] *Palacky University in Olomouc, Faculty of Science*

Level of scientific reasoning was measured using the Lawson test of scientific reasoning for 1st-year students entering the Faculty of Science at Palacký University in Olomouc and 3rd-year pupils in grammar school in Czechia. Besides the standard item and test characteristics, we also identified possible factors affecting the scores. We tested five hypotheses based on sex of the examinees, field of study at university and grammar school, year of testing comparison of scores between university students and grammar school pupils.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Poster session / 160

Light intensity does not always decay with the inverse of the square of the distance: an open-inquiry laboratory

Authors: Arturo Marti[1]; Cecilia Stari[1]; Marcos Abreu[1]; Martín Monteiro[2]

[1] *UdelaR*

[2] *Universidad ORT Uruguay*

Corresponding Authors: marti@fisica.edu.uy, ceciliastari@gmail.com

The square inverse law with distance plays an important role in many fields of physics covering electromagnetism, optics or acoustics. However, as every law in physics has its range of validity. We propose a laboratory where we challenge these concepts by proposing experiments where the intensity of light decays linearly or even remains constant over a range of distances. This laboratory, initially proposed in the context of the COVID19 pandemic, has the virtue of challenging intuition and encouraging the critical spirit of the students.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / 70

Survey on physics knowledge to evaluate the effects of gender gap on orientation towards STEM courses

Author: nicola gherardo ludwig[1]

Co-author: Paolo Teruzzi

[1] *Università degli Studi di Milano*

The aim of this research is to monitor the gender gap in a sample of high school and university students, through a survey by multiple choice test in a well-defined sector of physics teaching (Nuclear Physics). The survey results were analyzed and compared with a fixed threshold reference value and used as a measurement of empathy toward hard-science topics. The comparison with gender numerousness in the five pupil populations can be used as a parameter to understand how gender unbalance can influence the attitude toward STEM courses of male/female.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Poster session / 311

Categorisation of interdisciplinary problems in Physics and Science

Author: Rosaria Lena[None]

Co-authors: Charlie Burnett [1]; Frances Breslin [1]

[1] *SUPA, School of Physics and Astronomy, University of Glasgow, Glasgow G12 8QQ, United Kingdom*

In this research, we aim to gain insights into the epistemological factors facilitating interdisciplinary skill development in students, during and after the degree. We designed and conducted surveys containing similar problems presented in various disciplinary contexts, and participants from Physics and other Schools in Science and Engineering were asked to categorise these problems based on problem-solving approaches. Preliminary findings suggest that joint-honours students in Science outperform their single-honours counterparts in connecting topics across disciplines, transcending superficial problem features, and that such ability improves with expertise in Physics.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / 171

Identifying Precursors of University Drop-Out in Physics and STEM Undergraduate Courses

Authors: Italo Testa[1]; Lucio Palazzo[2]; Raffaella Passeggia[3]; Giovanna Esposito[3]

[1] *University Federico II Naples*

[2] *Department of Political Sciences*

[3] *Department of Humanities*

The university drop-out is a complex phenomenon that has different implications both at an individual and at a structural level. In this poster, we present a study to explore the relationships between engagement, psychological distress, academic motivation, the intention to leave the university, the actual drop-out and academic performance. The study will involve about 1000 students enrolled in the first year of Physics and Science-Technology-Engineering-Mathematics university courses. The preliminary results will be presented at the conference. The study may help to develop guidance interventions aimed at addressing the "leaky pipeline"in physics and STEM undergraduate courses.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / 83

The challenges of teaching medical radiation technology without a high school physics background in Australian universities

Author: Pradip Deb[1]

[1] *RMIT University Australia*

This paper explores the challenges faced by Australian universities in teaching Medical Radiation Technology (MRT) to students without a high school physics background. The primary challenges identified include a lack of basic physics knowledge, difficulty in understanding complex MRT concepts, and limited problem-solving skills. These challenges often hinder students' ability to grasp advanced topics and engage in critical thinking, which are crucial for advanced medical imaging, nuclear medicine, and radiotherapy. To overcome these challenges, universities require to offer remedial physics courses. However, this is a complex issue requiring further research and discussion among educators and stakeholders in the field.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / **193**

Continuous transition from Fraunhofer and Fresnel diffraction regimes with a triangular slit

Author: Alessandro Salmoiraghi[1]

Co-authors: Luigi Gratton [1]; Marco Di Mauro [1]; Pasquale Onorato [1]; Stefano Oss [1]

[1] *University of Trento*

Corresponding Author: a.salmoiraghi@unitn.it

We introduce an economical quantitative optical experiment aimed at acquainting students with the near- and far-field diffraction regimes, as defined by the Fresnel-Kirkhoff and Fraunhofer models, respectively. This experiment demonstrates the transition using a triangular slit. It incorporates the use of cost-effective, easily accessible materials, along with a basic camera, typical of those available in common smartphones. The experimental setup was tested on graduate students in mathematics and physics who are prospective high school teachers.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / **312**

Basic Physics Laboratory - a space where undergraduate students develop hard and soft skills crucial not only for scientific career

Author: Malgorzata Wawrzyniak-Adamczewska[1]

[1] *Faculty of Physics, Adam Mickiewicz University, Poznan, Poland*

We discuss role of the Basic Physics Laboratory classes in the didactic process at the Faculty of Physics of the Adam Mickiewicz University. We show that these classes allow the improvement of specific hard skills as well as soft competences, that make students competitive in today's job market. The skills taught in the Basic Physics Laboratory are therefore crucial not only for the development of a future scientific career.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / 84

Critical thinking in quantum physics learning: Development of a domain specific model

Author: Nilüfer Didiş Körhasan[None]

Co-authors: Farahnaz Sadidi ; Gesche Pospiech

Corresponding Author: niluferdidis@gmail.com

This study aims to develop a critical thinking (CT) model suited for pre-service physics teachers engaged in quantum physics learning. To achieve this, Halpern's Critical Thinking framework is used, due to its relevance to physics education and its focus on critical thinking skills applicable to quantum physics phenomena like probability, indistinguishability, uncertainty, superposition, measurement, entanglement, and spin. By developing this model, the development of teaching materials is facilitated, enabling the investigation of CT skill development in students. Viewing this model as an initial phase, the broader objective is to provide insights for enhancing teacher training programs in quantum physics.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / 323

Research in Physics Teaching in the Inter-American region from the IACPE

Author: Eduardo Montero[1]

[1] *Escuela Superior Politécnica del Litoral (ESPOL)*

Corresponding Author: emontero@espol.edu.ec

A synthesis of the Inter-American Conferences on Physical Education, their organization and areas of interest is presented, considering the papers presented in the last three held (Uruguay 2019, Costa Rica-Guatemala 2021 and Brazil, 2023). The themes and subthemes thereof and the analysis criteria of the papers presented therein are presented

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Poster session / 4

Examining naïve conceptions regarding the enlightenment of a light bulb filament

Authors: Markus Sebastian Feser[1]; Ingrid Krumphals[2]

[1] *IPN –Leibniz Institute for Science and Mathematics Education*

[2] *University College of Teacher Education Styria*

Within the present study, we empirically examine an example frequently cited in the literature on physics teaching to illustrate that one's naive conceptions can influence the observation of a natural phenomenon. Conducted through an online survey, we challenged 158 participants to predict, reason, and observe the enlightenment of a light bulb filament. Our interim results reveal a contradiction to the description within literature on physics teaching since our participants rarely observed outcomes consistent with their own predictions (κ=.111) and reasonings (κ=.184). Details on the present study's design as well as further interim results are outlined in this proposal.

How would you like to present your contribution?:

Hybrid from my own country (later in the conference day, best for Americas)

Target education level:

General

Category:

Formal Education

Poster session / 196

The MaSCot project: Materials science communication in informal learning environments

Authors: ELENI BOTZAKI[1]; Athanasia Kokolaki [1]; Maria Gavala[1]; Argyris Nipyrakis[1]; Emily Michailidi[1]; Dimitris Stavrou[1]

[1] *University of Crete*

MaSCot project aims to upgrade the informal science learning experiences regarding the communication of materials science developments through the collaboration of the Department of Primary Education and the Materials Science and Technology department of the University of Crete. This paper presents the preliminary results of the analysis of the educational visits currently organized by the two departments, along with the analysis of the communicated scientific content, detecting the scientific concepts and applications related to societal aspects and students' ideas about those.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Informal Education

Poster session / **85**

Trial of a New University Curriculum for Mathematics, Data Science, and AI Education

Author: Naoshi Takahashi[None]

Co-authors: Eiichi MIYAZAKI ; Hidenori YOSHIDA ; Kayo NISHIMOTO ; Shiori KUBO ; Shuhei FUJISAWA ; Toshihiro HAYASHI

Corresponding Authors: miyazaki.eiichi@kagawa-u.ac.jp, takahashi.naoshi@kagawa-u.ac.jp, fujisawa.shuhei@kagawa-u.ac.jp

Japan's AI strategy requires higher education institutions to train data scientists based on mathematical science. We have developed and implemented a new curriculum for "Mathematics, Data Science, and AI" education at Kagawa University. This curriculum consists of a literacy level, an applied basic level, and an advanced program. Student testing and evaluation results confirm that the program is generally successful.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / **220**

Understanding reversible and irreversible processes through activities

Authors: Saurabhee Huli[1]; Shirish Pathare[2]

Co-author: Bhagyashri Latad [3]

[1] *Homi Bhabha Centre for Science Education, TIFR, India*

[2] *Homi Bhabha Centre for Science Education*

[3] *Muktangan, Pune*

Understanding reversible and irreversible processes in thermodynamics presents a significant challenge for undergraduate physics students in India. The idealized nature of reversible processes often proves difficult to replicate in laboratory settings. In our activity, inspired by the widely recognized demonstration of food colour drops in highly viscous liquids, we provide students with a visual representation accompanied by graphical evidence of reversible process. By manipulating the viscosity

of the liquid, we also illustrate irreversible processes within this activity. The analysis of these processes was conducted using the open-source video analysis software "TRACKER," enhancing the comprehensibility and accessibility of our findings.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / 135

Development of Design Principles on the Planning of Didactic Sequences that use Science Fiction and Superhero Films and Series in the Teaching of Modern Physics

Author: Miguel Peclat Teixeira[None]

Co-author: Raul dos Santos Neto [1]

[1] *Federal Center for Technological Education of Rio de Janeiro*

Traditional educational institutions are no longer the main source of scientific knowledge for students since the socio-technological transformations of the second half of the 20th century. This role goes to the most varied forms of media. Also, not all physics topics are simple to deal with in high school. Movies and series intrigue students and make them raise questions to the physics teacher. In this way, this work proposes to develop design principles on the planning of didactic sequences that use science fiction and superhero films and series in the teaching of modern physics. Four Design Principles were developed.

How would you like to present your contribution?:

Hybrid from my own country (later in the conference day, best for Americas)

Target education level:

General

Category:

Formal Education

Poster session / 316

Advanced Modeling, Scientific Computing & Data Analysis with Open SageMath

Authors: Dominik Borovský[1]; Jozef Hanč[2]

[1] *Pavol Jozef Šafárik University in Košice*

[2] *P. J. Safarik University*

Corresponding Author: dominik.borovsky@student.upjs.sk

Our contribution addresses the computational challenges in physics and STEM education posed by advanced models. We introduce SageMath, a Python-based CAS software that integrates numerous open-source packages. We illustrate two pivotal modeling features: the desolve_odeint procedure for fast and accurate numerical solutions of differential equations and the LMFIT library for fitting their parameters directly with experimental data. As a professional science tool, SageMath demonstrates potential in education, enabling the model of complex real-world situations and bridging the gap between professional and educational computational tools.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / 89

The flat earth model –mapping misconceptions and failures

Author: Efraim Yehuda Weissman[1]

[1] *Jerusalem College of Technology*

This research tries to map the failures and misunderstandings that lead to the perception of the earth as flat, and sort them into two types: the lack of scientific knowledge, and misconceptions about the nature of science. From this it is possible to propose educational emphases that can deal with these perceptions.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Non-formal Education

Poster session / 318

Social Learning in Action: Asynchronous Perusall Colloquiums in Pre-Service STEM Teacher Training

Authors: Dominik Borovský[1]; Jozef Hanč[2]; Martina Hancova[3]

[1] *Pavol Jozef Šafárik University in Košice*

[2] *P. J. Safarik University*

[3] *P.J. Safarik University in Kosice, Slovakia*

Corresponding Author: jozef.hanc@upjs.sk

Our case study examines the shift from traditional teacher training colloquia after teaching practicums to asynchronous Perusall conferences. Two groups of master's students (N = 6 per group) in STEM fields participated in this research. Post-practicum, each student uploaded three video presentations on their teaching experiences to the social reader Perusall, which were then discussed asynchronously. Preliminary findings indicate that students engaged twice as long as in traditional settings and generated ten times more annotations. Detailed data analysis using open data science, machine learning, and AI tools will be presented at the conference to show student feedback and perspectives.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / 281

Assessing the Impact of Ungrading in a First-Year Mechanics Course at a Japanese Engineering College

Author: Shuji MUNEJIRI[1]

Co-authors: Aishi YAMAMOTO [2]; Syuma YASUZUKA [2]

[1] *Hiroshima university, Japan*

[2] *Hiroshima Institute of Technology, Japan*

The effect of not giving grades for assignments was investigated in calculus-based introductory mechanics courses at a Japanese engineering college. In the class that was treated as a control group, assignments were graded. In the experimental group class, assignments were given submission points regardless of content, and only feedback was provided. Final exam scores were higher in the experimental group where assignments were not graded. Significant differences were found, especially in the group of students who had lower scores on the pretest.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / 263

Between teaching and learning: pre-service physics teachers' teaching experience

Authors: Lydia Cehákova[1]; Martin Chvál[1]

[1] *Charles University*

Higher education institutions providing education of future physics teachers in Czechia experienced lately an increase of students, who are teaching apart from their mandatory teaching practice. To understand this phenomenon a questionnaire survey on students'motivation and teaching experience was prepared and conducted among 80 Czech students of physics education. This contribution presents the methodology of questionnaire preparation and descriptive analysis of first results focusing on a workload of physics students-teachers and their motivation to conduct own teaching during studies.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / 114

A relationship between collisions and the Betz limit

Author: Joao Pereira[1]

[1] *UNIRIO*

Abstract. The so-called Betz limit is commonly used to calculate how much mechanical power can be collected from the wind. According to this limit, no mechanism can capture more than (16/27) of the kinetic energy in the wind flow. In this work, a first principles derivation of the Betz limit is presented. It includes elements of linear momentum transfer in the fluid dynamics context in a collision between a fluid and a solid collector.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / 112

Learning objects as teaching resources for teaching Physics

Author: LELYS ANDRES UGALDE VELASQUEZ[None]

Co-author: CARLOS ALBERTO MARTINEZ BRIONES [1]

[1] *UNIVERSIDAD POLITECNICA SALESIANA*

Corresponding Authors: lugalde@ups.edu.ec, cmartinezb@ups.edu.ec

This work is focused on the ORA design and validation of an educational innovation, facilitating the teaching of Physics through innovative strategies that generate significant learning, such as the understanding and use of Physics knowledge in higher level students. This research is based on a qualitative methodology, in which a learning object supported by technological resources was used. Collaborative work was achieved in the classroom for the construction, understanding and application of Physics concepts. The attitude shown by the students towards learning Physics concepts was positive.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Poster session / 268

Measurement of the gravitational acceleration by secondary school and university students with the use of remote laboratories

Author: Pavel Brom[1]

Co-authors: Radka Hakl [1]; František Lustig [2]

[1] *Škoda Auto University*

[2] *Jan Evangelista Purkyně University*

Corresponding Author: pavel.brom@savs.cz

This contribution summarizes several theoretical models for the value of the gravitational acceleration g. Significant deviations among the predicted theoretical values from these models can be observed. They are compared with experimental values from worldwide open remote laboratories within the World Pendulum (WP@ELAB) Project. Moreover, behaviour of several UJEP and Škoda Auto University students in the Czech remote laboratory with a mathematical pendulum with variable length at UJEP is correlated with the quality of the submitted reports of these students involved in the pedagogical research. The most interesting findings of the first log file analysis are presented and discussed.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Poster session / **182**

Amusement parks, playgrounds and the equivalence principle – Physics for the whole body and a smartphone or small toys

Author: Ann-Marie Pendrill[1]

[1] *Lund university*

What your body feels in swings, carousels or rollercoasters is related to the forces required to change motion. These forces can be visualized with small toys or be measured by a smartphone accelerometer, giving data that can be analysed in the physics classroom. The embodied experiences, as well as accelerometer data, depend on the equivalence between inertial and gravitational mass, which often leads to surprising consequences, that can deepen the understanding of Newton's laws. The poster will present a number of visual examples of experiments, demonstrations and analyses that challenge incomplete understanding.

How would you like to present your contribution?:

Hybrid from my own country (early in the conference day, best for Asia, Australia)

Target education level:

General

Category:

Non-formal Education

Poster session / **238**

A Survey with Primary School students on the use of an Arduino-Uno based pyranometer and the temperature gauge

Author: Zografia Papanagiotou[1]

Co-authors: Alexandra Triantafyllia Papanagiotou [2]; Anthimos Chalkidis [3]; Aristotelis Gkiolmas [4]; Artemisia Stoumpa [3]; Constantine Skordoulis [5]; George Koutromanos [5]; Vasiliki Psoma [3]

[1] *Student at the National Kapodistrian University of Greece*

[2] *Student at the National Technical University of Athens*

[3] *National Kapodistrian University of Greece*

[4] *Professor-Aristotle University of Thessaloniki*

[5] *Professor-National Kapodistrian University of Greece*

This paper focuses on a teaching intervention on the measurement of temperature and the intensity of solar radiation, by the students, accompanied by a survey with anonymous questionnaires. The sample consisted of students of the last grade of the Greek Primary school (grade 6). The didactic intervention and the measurement of the solar radiation and the temperature are carried out through an Arduino Uno and an Arduino Nano Ble arrangement. After the teaching intervention, through the provision of pre-test and post-test, the students' ability to describe and measure the concept of solar radiation and temperature is recorded and evaluated.

How would you like to present your contribution?:

Hybrid from my own country (early in the conference day, best for Asia, Australia)

Target education level:

General

Category:

Formal Education

Poster session / **134**

Long-lasting opinions on physics and physics education in the Czech Republic

Author: Tomáš Kopřiva[1]

[1] *Charles University*

The aim of this contribution is to showcase the results of a nation-wide survey conducted in the Czech Republic on general public regarding the long-lasting opinions on physics and physics education originating mainly in lower secondary school and high school physics classrooms in collaboration with the Institute of Sociology. The results of this survey aim to support the modern ideology of focusing more on conceptual understanding and inquiry-based approach to physics education rather than traditional methods focused on formulae and constant memorization.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Workshop / **300**

The IYPT Ideas in Daily Teaching and Learning

Author: Dobromiła Szczepaniak[1]

[1] *Akademickie Liceum Ogólnokształcące Politechniki Wrocławskiej*

Teaching physics to teenagers is a fulfilling adventure. Complex skills essential to become competent in the subject, and activities one can engage students with is a shield from boredom. However, the complexity of physics requires continuing effort, hence less motivated students are prone to failure. There are numerous ways of maintaining enthusiasm for science. This is about one of my favourite. Yearly the International Committee releases seventeen physics problems for teenagers and their teachers to enjoy.
I will share my excitement in International Young Physicists'Tournament, and hopefully, inspire to use it as an efficient teaching tool.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Workshop / 175

Using the EP3 Guide to Address Concerns with Low Enrolments in Physics Departments

Author: Michael Wittmann[1]

[1] *American Physical Society*

Physics departments throughout the world share a concern that threatens their well-being and existence: low student enrolments. The Effective Practices for Physics Programs (EP3) Guide (ep3guide.org) provides a set of practices and strategies to help with both the recruitment and the retention of students. In this workshop, we will describe the EP3 Guide, present data from US universities about threats to departments, and discuss a scenario from a fictional large department to show how the EP3 Guide can be used to help a department respond, gather data to help make decisions, and make changes to improve enrolment.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Discussion workshop / 256

Embracing changes together to improve physics teaching

Authors: Eilish McLoughlin[None]; Claudio Fazio[1]; Dagmara Sokołowska[None]

[1] *Università degli Studi di Palermo*

This workshop facilitates global exchange and discussion on current opportunities and challenges influencing physics teaching and teacher education, from early childhood to university level. The rapidly changing landscape of the global economy and society in the XXI century demands new approaches to be adopted to recruit, upskill, and educate physics teachers so they can design and facilitate blended learning experiences. Preparing physics teachers with the necessary knowledge and skills to address emerging global issues requires cooperation between all ¬the key shareholders to identify future perspectives and embrace changes together.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Workshop / **221**

Innovation in Teaching/learning physics in Master IDIFO

Authors: Lorenzo Santi[None]; Marco Giliberti[1]

Co-authors: Maria Luisa Chiofalo [2]; Paolo Gianozzi [3]; Stefano Urbinati [3]

[1] *Università degli Studi di Milano*

[2] *University of Pisa*

[3] *University of Udine*

Implementing Teachers' Professional Development is a challenge, which is based on a consistent amount of physics education research (PER). The innovation in teaching/learning required today to build competence and autonomy for young people represents a strong challenge for teachers. In Italy, there is no institutional program for the professional development of teachers, but the PLS Plan (PLS) offers the opportunity for a qualified professional development by means of cooperative work between school and university and in that framework the Master IDIFO build an original TPD able to integrate PER and praxis in school activities.

How would you like to present your contribution?:

Hybrid from my own country (later in the conference day, best for Americas)

Target education level:

General

Category:

Formal Education

Workshop / **174**

QTris: a new game for teaching quantum physics

Authors: Alioscia Hamma[1]; Irene Marzoli[2]; Maria Bondani[3]

Co-authors: Massimiliano Malgieri [4]; Maurizio Dabbicco [5]; Michela Nazzaro [6]; Sergio Caprara [7]

[1] *Università degli Studi di Napoli Federico II, Italy*

[2] *Scuola di Scienze e Tecnologie, Università degli Studi di Camerino, Italy*

[3] *Istituto di Fotonica e Nanotecnologie-CNR-IFN, Como, Italy*

[4] *Dipartimento di Fisica, Università di Pavia, Italy*

[5] *Dipartimento di Fisica, Università degli Studi di Bari Aldo Moro, Italy*

[6] *Dipartimento di Fisica 'Ettore Pancini', Università degli Studi di Napoli Federico II, Italy*

[7] *Dipartimento di Fisica, Università di Roma Sapienza, Italy*

Corresponding Author: maria.bondani@uninsubria.it

In this workshop we present QTris, a novel game for teaching and learning quantum mechanics based on a consistent quantum extension of the classical game tic-tac-toe.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Workshop / 101

Hands-on with Relativity Lab: a simulation environment for special relativity in secondary education

Author: Paul Alstein[1]

Co-authors: Kim Krijtenburg-Lewerissa [1]; Wouter van Joolingen [1]

[1] *Utrecht University*

The theory of special relativity is a notoriously difficult learning objective, especially in secondary education. Relativistic phenomena are counter-intuitive and very remote from everyday experience. Moreover, it is impossible to observe relativistic effects in practical experiments. We designed an online simulation environment, called Relativity Lab, in which students can construct and observe virtual relativistic experiments. A team of researchers and teachers collaboratively designed, performed and evaluated a three-lesson series centered around the use of Relativity Lab. In this workshop, participants are invited to experience Relativity Lab hands-on, with the aim of embedding Relativity Lab in their own teaching practice.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Workshop / 165

Empowering learning through dynamic modelling activities to enhance physics education

Author: Zuzana Jeskova[None]

Co-author: Katarína Kozelková

Corresponding Authors: katarina.kozelkova@upjs.sk, zuzana.jeskova@upjs.sk

Inquiry-based science education emphasizes active learning where students, through inquiry, answer a research question applying a scientific method based on experimentation or modelling approach. Experimentation is a primary means of inquiry. Modelling, as another essential aspect of the inquiry approach, allows students to represent and manipulate abstract concepts, explore relationships between variables and make predictions about the system behaviour. In the workshop, the principles of dynamic modelling will be introduced. Participants will develop their own dynamic models within the COACH learning environment software. Through hands-on activities, they will get insight how to integrate dynamic modelling activities into their educational practices.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Workshop / **32**

Measuring time - from sundials to exploring the pendulum

Author: Irena Dvořáková[1]

[1] *Charles University, Faculty of Mathematics and Physics, Prague*

The workshop offers a research activity designed for the first year of lower secondary school on the topic of timekeeping. Students create a non-linear graph from their own data and discuss its properties. They reflect on the exploratory cognitive cycle and become aware of the knowledge, skills and competences they have acquired during their learning. Workshop participants will first go through the lesson as learners and then discuss its relevance from the teacher's perspective.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Symposium / **321**

Innovative Approaches in Physics Education: Addressing Challenges in Latin America

Author: Ignacio Julio Idoyaga[1]

[1] *Universidad de Buenos Aires*

Corresponding Author: ignacio_idoyaga@hotmail.com

This symposium highlights research in physics education in Latin America, focusing on technological and collaborative innovations. It features a professional learning community in Chile that uses real astrophysical data, remote laboratories in Costa Rica that facilitate distance education, a critical analysis of pseudoscientific discourses in Brazil, and the use of phenomenography in Mexico to improve conceptual understanding. These initiatives underscore the importance of interdisciplinarity and adaptation to specific contexts, proposing greater technological integration and international collaboration to enhance physics education in the region.

How would you like to present your contribution?:

Hybrid from my own country (later in the conference day, best for Americas)

Target education level:

General

Category:

Formal Education

Symposium / **69**

IMPRESSions of the Invisible: New Approaches in Modern Physics Education

Authors: Magdalena Kersting[None]; Julia Woithe[1]

Co-authors: Oriel Marshall ; Paul Alstein ; Urban Eriksson ; Tejinder Kaur

[1] *CERN*

Corresponding Author: mkersting@ind.ku.dk

This symposium, organised by the International Modern Physics & Research in Education Seminar Series (IMPRESS), addresses the intangible and abstract nature of modern physics concepts. Four contributions explore innovative approaches for conceptualising topics of relativity, quantum physics, and astrophysics across primary to tertiary education. Contributions include physical analogies for exoplanets, a simulation-based environment for special relativity, expert strategies for understanding spatiotemporal scales, and a spiral curriculum introducing modern physics to primary school students. These diverse approaches are united by their potential to make intangible phenomena comprehensible for students and embody IMPRESS's mission to enhance the impact of modern physics education.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Symposium / 27

Climate Change Education in Physics Teaching

Authors: Thomas Schubatzky[1]; Matthias Fasching[2]; Magdalena Micoloi[3]; Sarah Wildbichler[1]

[1] *University of Innsbruck*

[2] *University of Vienna*

[3] *TU Dresden*

Climate change is one of the most pressing issues of our time. Therefore, physics education should help students address this issue. This symposium delves into approaches to integrating climate change education within physics teaching. The first contribution explores greenhouse effect learning environments in secondary education. The second talk presents the evaluation of climate change tutorials. The third contribution introduces a critical thinking test regarding climate change. The last contribution delves into teacher attitudes towards assessing climate protection measures. These contributions collectively offer insights into pedagogical strategies, assessment methodologies, and educator perceptions crucial for effective climate change education in physics.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Discussion workshop / 156

Panel discussion on learning goals and their assessment in physics labs

Authors: Ian Gardner Bearden[1]; Paul Logman[2]

Co-authors: Micol Alemani ; Sergej Faletic

[1] *University of Copenhagen (DK)*

[2] *Leiden University*

Corresponding Authors: sergej.faletic@fmf.uni-lj.si, plogman@cern.ch, alemani@uni-potsdam.de, bearden@nbi.dk

A panel discussion on physics labs at all levels of education is proposed. It will address open questions on learning goals and their assessment and the interplay between those two. Two experts in the field will initiate the discussion. The workshop will end with an outlook to the future. Results of the discussion will be reported back to the community.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Workshop / 289

Indians, bells and whistling bottles - an inquiry-based learning unit for enhancing students' motivation, creativity and empirical skills

Author: Dagmara Sokołowska[None]

During the workshop, we will present a ready-to-use unit to introduce the learners to sound frequency, sound propagation in matter, and the sound resonator. The module is embedded into the inquiry-based learning (IBL) cycle based on everyday materials, with particular emphasis on the first phase of the cycle (Brainstorming) created as a storyline, which aims to raise students' motivation and interest in the subject. The unit consists of three parts, developed at different levels, which can be implemented at all levels of education, as a sequence or separately, depending on the student's age.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Workshop / 199

An overview of the outcomes of the GIREP Malta Webinars 2020 and 2021

Author: Joan BORG MARKS[1]

[1] *University of Malta*

This paper offers a brief description of some of the outcomes from the GIREP Malta Webinars 2020 and 2021. A lot was presented and discussed through these webinars. All is deemed important. This presentation will, however, only highlight some of the predominant issues. The aim is to remind the readers of what participants felt were vital ways of how physics teachers can be better trained throughout their carrier so that students can be helped to achieve their potential. Issues that really matter in physics teacher education will be outlined.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Workshop / 77

Creating a Student-Centered Collaborative Learning Environment in a University Physics Classroom

Authors: Gerald Feldman[None]; Guillaume Schiltz[None]

An active-learning workshop is offered to provide an example of a collaborative group-learning pedagogical environment for introductory physics at the university level. Participants will engage in various hands-on and minds-on exercises to illustrate how such a dynamic classroom can transform the strategy for teaching physics in university classes. A discussion about the benefits and challenges of this innovative approach will help guide the participants in adopting this teaching methodology in their own physics classes. We are working to establish a network of pedagogical innovators among the participants so that this type of approach can be more widely disseminated.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Discussion workshop / 244

Embracing changes together to improve physics learning

Author: Claudio Fazio[1]

Co-authors: Dagmara Sokolowska [2]; Eilish McLoughlin [3]

[1] *Università degli Studi di Palermo*

[2] *Smoluchowski Institute of Physics, Jagiellonian University, Lojasiewicza 11, 30-348 Krakow, Poland*

[3] *Centre for the Advancement of STEM Teaching and Learning and School of Physical Sciences, Dublin City University, Dublin, Ireland*

This workshop facilitates exchange and discussion on current opportunities and challenges influencing physics learning. Physics is important for culture and is the foundation of many technological advancements. As technology progresses, a deeper understanding of physics becomes essential for innovation and development in fields such as engineering, medicine, telecommunications, and energy production. Moreover, with challenges like climate change, and the search for sustainable energy, understanding physics is essential for creating a sustainable future. Preparing students with the necessary physics knowledge and skills demands cooperation between all the key shareholders to identify future perspectives and embrace changes together.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Oral presentations / 55

From school to research: a problem-solving activity to engage high school students in STEM

Author: Arianna Steri[1]

Co-authors: Federico Gabriele [1]; Matteo Tuveri [1]; Walter Bonivento [1]

[1] *INFN Cagliari*

Corresponding Author: arianna.steri@ca.infn.it

Results in Physics Education Research suggest that cooperative problem-solving (CPS) pedagogy enhances students'creativity and motivation toward STEM. Researchers in the Aria Project, a project aimed at the cryogenic distillation of stable isotope, designed the "Aria Masterclass", an educational program devoted to high school students (fourth and fifth classes), to improve scientific awareness and bolstering motivation on contemporary physics. Students solved a contextualized exercise based on Aria research topics by using a CPS-inspired methodology to size a distillation column. We discuss the design of the activity and results on students' learning and STEM engagement of a 2023-2024 Italian experimentation.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Informal Education

Oral presentations / 267

Sophisticated scientific reasoning process in five-year-old children using ISLE-based activities

Author: Simon Peter Leban[None]

Co-author: Valentina Bologna

Can preschool children act as scientists discovering the properties of the colour of the water? In our pilot study, we engaged a group of eight five-year-old children in scientific reasoning, enacting an ISLE process. They were guided in an observational experiment, discovering the colour of the water in different glasses, and they tested their hypothesis based on a prediction of a testing experiment. In the end, they were able to generalise the results to other situations (application experiment). Even with the necessary simplifications, our research highlights that children, if appropriately stimulated, are capable of carrying out scientific reasoning.

How would you like to present your contribution?:

Hybrid from my own country (early in the conference day, best for Asia, Australia)

Target education level:

Early Science/Primary

Category:

Formal Education

Oral presentations / **110**

A hands-on STEM project on the drought in Spain: The impact on scientific and green skills of Dutch high school students

Author: Cathy Baars[None]

Dutch high school students often question the relevance of learning physics. Addressing this, a STEM project was initiated, challenging students to use their physics knowledge to tackle Spain's drought issues. The project aimed to enhance skills in problem-solving, technical design, automation, scientific literacy, and awareness of career opportunities in physics, providing a real-world context to demonstrate the subject's relevance and the significance of climate change. The impact was evaluated by comparing students without participation, those who only completed the preparatory project, and those who also engaged in hands-on activities in Spain, showcasing the value of applying physics in real-world scenarios.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Non-formal Education

Oral presentations / **100**

Practical evaluation of the possibilities of integrating Large Language Models in physics laboratory instruction

Authors: Marina Babayeva[1]; Ralf Widenhorn[2]; Travis Kregear[2]

[1] *Charles University*

[2] *Portland State University*

A team of researchers from Portland State University (PSU) and Prague's Charles University pioneered the integration of OpenAI's GPT-4 Large Language Module (LLM) into the introductory physics laboratory, serving as a virtual teaching assistant. A class of 26 students participated in a pilot implementation of the AI assistant for introductory physics at PSU. We evaluated students' interactions with the chatbot, assessed the quality of the LLM's responses, and conducted surveys to gather qualitative insights from students'experiences and attitudes. This contribution presents the key findings of our pilot study, including examples from the transcripts and surveys.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 95

Comparing the two quantum revolutions: development of a teaching module to value their cultural and conceptual scope

Author: Sara Satanassi[None]

Co-author: Olivia Levrini [1]

[1] *Department of Physics and Astronomy, University of Bologna*

We are in the midst of the Second Quantum Revolution, which succeeded the First in the early 20th century. The First revolution revolved around the wave-particle duality and led to the emergence of technologies like transistors and lasers. The Second heralds a new technological epoch encompassing quantum sensors, communication, computers, and simulators. This revolution is changing the research and our political, societal, and educational landscape, calling educators to promote quantum literacy and prepare the forthcoming quantum experts. We present a module for high school students and teachers, which stimulates reflections on the cultural and conceptual implications of the ongoing revolution.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 78

Teaching a Quantum Physics Class Using a Student-Centered Collaborative Learning Approach at the University Level

Author: Gerald Feldman[None]

Co-authors: André Heck [1]; Auke-Pieter Colijn [2]; Marcel Vreeswijk [2]; Natasa Brouwer [3]

[1] *Korteweg-de Vries Institute for Mathematics, University of Amsterdam*

[2] *Nikhef National institute for subatomic physics (NL)*

[3] *Institute of Physics, University of Amsterdam*

We have redesigned a Quantum Physics class at the University of Amsterdam using a collaborative group-learning approach following the SCALE-UP methodology. In this active environment, students work together in groups on conceptual/numerical exercises that are monitored in class by the instructor and Teaching Assistants. Formal lecturing is reduced to a minimum, and students are expected to come to class prepared to work on the in-class assignments. Pre-class "Warmups" help students prepare and gauge their understanding; post-class homework assignments provide opportunities to practice the course material. We report on changes in student performance, motivation, and attitude which resulted from our innovation.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 151

The effect on the perception of quantum science and technology with secondary school students through a university-based quantum lab and game experience

Authors: Brenda Rovers[None]; Henk Buisman[1]; Julia Cramer[2]; Michiel Thijssen[1]

[1] *Leiden Institute of Physics*

[2] *Science Communication and Society Department, Leiden University*

A visit to Quantum Rules! at Leiden University allows secondary school students to appreciate the principles of quantum science and technology. We report the outcomes of quantitative research on the effect on students' perceptions of quantum science and technology, following the addition to the Quantum Rules! experience of a serious game that uncovers ways in which quantum is part of daily life.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Informal Education

Oral presentations / 87

Development and transferability of scientific abilities in an ISLE-based lab course

Author: Sergej Faletic[None]

Co-authors: Gorazd Planinsic [1]; Nastja Mahne

[1] *Faculty of Mathematics and Physics, University of Ljubljana*

Corresponding Author: sergej.faletic@fmf.uni-lj.si

We will report on how students' scientific abilities as measured by Rutgers scientific abilities rubrics changed over the course of two semesters. In each semester students do one lab per week. For each lab, they submit a report, receive feedback and then submit a revised version. We investigated two research questions: 1) How did students'scores on each ability change between the initial and revised submissions? 2) How did students'scores on each ability change between the initial submissions for different labs over the course of two semesters?

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 131

Research on conceptual understanding of thermodynamic and transport phenomena of solids - microscopic models of electrical and thermal conductivity

Author: Lejla Jelovica[1]

Co-author: Nataša Erceg [2]

[1] *Faculty of Science, University of Split and Faculty of Health Studies, University of Rijeka, Croatia*

[2] *Faculty of Physics, University of Rijeka, Croatia*

Corresponding Author: lejla.jelovica@uniri.hr

Knowledge of solid-state physics, such as electrical and thermal conductivity, is very important due to its influence on the development of modern technologies. Although these phenomena appear in the curricula of elementary school, secondary school and universities, students have many incorrect ideas about them. In order to gain detailed insight into students' understanding, we have developed a concept inventory on microscopic models of electrical and thermal conductivity of solids (METCS). By applying the test to a sample of Croatian first-year university students, some already known incorrect ideas were confirmed and a large number of new ones were discovered.

How would you like to present your contribution?:

Hybrid from my own country (early in the conference day, best for Asia, Australia)

Target education level:

University

Category:

Formal Education

Oral presentations / 99

Augmented Reality in Electromagnetism: Which representations best support students' understanding?

Author: Bermann Steinmacher[None]

Co-authors: Andreas Lichtenberger [1]; Andreas Vaterlaus [1]; Barbara Gränz [1]; Christoph Hoyer [2]; Elsbeth Stern [1]; Jochen Kuhn [2]; Kristin Altmeyer [3]; Max Warkentin [2]; Peter Edelsbrunner [1]; Ralph Schumacher [1]; Roland Brünken [3]; Roman Schmid [1]; Sarah Hofer [2]; Sarah Malone [3]; Stefan Küchemann [2]; Zoya Kozlova [2]

[1] *ETH Zürich*

[2] *LMU München*

[3] *Universität des Saarlandes*

We have developed an Augmented Reality (AR) learning setup in which students investigate the Lorentz force and the superposition of magnetic fields with virtual representations including field vectors, field lines, a vector tripod, and combinations thereof. In an experimental classroom study with N = 77 students, we found no significant differences in conceptual understanding between the different AR conditions. However, exploratory analysis revealed that conditions employing the vector tripod showed better learning results regarding the conceptual knowledge on Lorentz force. Offering multiple as opposed to single virtual representations did not seem to enhance or hamper the acquisition of conceptual knowledge.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 204

Expanding physics education understanding through large-scale literature review using unsupervised natural language processing

Authors: Martina Caramaschi[1]; Olivia Levrini[2]; Tor Ole Odden[3]

[1] *Department of Physics and Astronomy "A. Righi", University of Bologna*

[2] *Department of Physics and Astronomy, University of Bologna*

[3] *Center for Computing in Science Education, University of Oslo*

Corresponding Author: martina.caramaschi2@unibo.it

We have thematically analysed papers from "The Physics Teacher"journal from its inception in 1963 to 2020, to understand what themes were prevalent in the history of physics teaching. The methodology combined an unsupervised machine learning (ML) method called Latent Dirichlet Allocation (LDA) into a qualitative analysis. Specifically, LDA allowed us to identify patterns of words that represent "topics", while researchers derived analytical process and interpretation of results. Our analysis found 13 topics displayed over time, grouped into content-focused topics, pedagogical, laboratory and data analysis-focused topics, and learning-theory topics, suggesting a shift from practices to considering relevant learning theories.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Formal Education

Oral presentations / **164**

Prompt engineering techniques to enhance Large Language Models' performance in introductory physics

Author: Giulia Polverini[1]

Co-author: Bor Gregorcic [1]

[1] *Uppsala University*

Prompt engineering has increasingly garnered attention with the widespread use of AI-based chatbots over the past year. The formulation of prompts highly impacts the output of chatbots, which rely on Large Language Models and thus generate text that is a statistically good fit with both its training data and the users'prompt. Through examples from introductory physics, this study shows how selected prompt techniques can enhance the performance of chatbots like ChatGPT. In our investigation, we observed that upon using two specific prompt engineering techniques, the chatbot' s responses improved both in the rate of correctness and quality of the argumentation.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / **172**

Self-Guided Learning in Quantum Technologies: Unveiling the Role of Grassroots Organizations in Education and Outreach

Authors: Adrian Schmidt[1]; Zeki C. Seskir[1]

[1] *KIT ITAS*

This study explores the intersection of goals and values in grassroot organisations for quantum technologies (QT) education, emphasizing the distinction between providing education and democratizing learning with inclusivity and accessibility. It analyses how these organisations navigate the early stages, balancing core values with sustainable growth in the specialised QT field. Strategic approaches, including creating educational ecosystems and fostering community engagement,

are uncovered. The research highlights potential vulnerabilities, particularly as members transition into professional roles. The paper contributes to the understanding of how emerging QT educational organisations balance ideological commitments with growth considerations, highlighting critical factors influencing their trajectory and impact.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Informal Education

Oral presentations / 248

Short-course on Communicating Science: Outcome of a Five-years Experience

Author: Maurizio Dabbicco[None]

Co-authors: Sandra Lucente [1]; Massimo Trotta [2]

[1] *Dept. of Physics, Univ. of Bari, Italy*

[2] *CNR-IPCF, UoS Bari*

Corresponding Author: maurizio.dabbicco@uniba.it

Communicating Science is an elective, inclusive, general-purpose course aimed at equipping students with some basic non-disciplinary skills. The Physics & Engineering students group mo-tivated by personal and professional interest, showed the best correlation with self-reported outcomes in terms of learning expectations, acquired skills, and self-confidence.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

General

Category:

Informal Education

Oral presentations / 76

Motivational and didactic efficacy of an interdisciplinary learning path on IR Reflectography and False Colour imaging of artworks

Authors: Francesca Monti[None]; Claudia Daffara[1]; Nicole De Manincor[1]

[1] *University of Verona*

We present an interdisciplinary didactic module at the high-school level about Infrared Reflectography and Infrared False Colour imaging of artworks jointly conducted by physicists with an art historian expert in heritage science. The teaching sequence includes use of do-it-yourself materials as well as professional instrumentation. It is shown that this interdisciplinary and practical didactic path succeeds in fostering students'(particularly female students') attitude towards learning physics and represents an effective way for introducing advanced topics in the field of radiation-matter interaction, while opening the way to untying some important conceptual knots related to colour image formation.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 90

Prospective physics teachers' perceptions and evaluations of ChatGPT in didactical tasks

Authors: Farahnaz Sadidi[None]; Thomas Prestel[1]

[1] *Germany*

Chatbots like ChatGPT represent new tools for generating text. This study aims to investigate their potential incorporation into prospective physics teacher training programs. An exploratory study involving prospective physics teachers (n=39) was conducted to explore their perceptions of ChatGPT' s use in educational contexts. Qualitative analysis of students' evaluations of ChatGPT3.5-generated responses to didactical tasks revealed its dual function as a tool for assessing students' didactical knowledge and critical thinking skills, while also teaching them media literacy. This could lead to the improvement of teacher training programs.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 74

New horizons: A quantum physics concept for grade 9 students

Author: Carsten Albert[1]

[1] *TU Dresden / IFW Dresden*

Corresponding Author: c.albert@ifw-dresden.de

The significance of quantum physics in secondary school curricula is increasing, raising the question of modern approaches to the topic for younger target groups. For this purpose, a state-of-the-art teaching concept has been developed to introduce quantum physics conceptually to grade 9 students, focusing on the electron spin in the context of the quantum computers. Formative evaluation revealed promising results and experiences. In the talk we report the development process of the concept and teaching materials as well as first findings from summative evaluation regarding student learning achievements, changes in affective variables and teachers' assessments.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 303

Understanding how students recognize and connect mathematics ideas in physics contexts: A pilot study

Author: Drew Rosen[1]

Co-authors: Reuben Meredith-Luthi [1]; Ross Galloway [1]

[1] *University of Edinburgh*

Corresponding Author: drosen@ed.ac.uk

A long-standing problem within physics education is the difficulty of transferring ideas learned in a mathematics context into a physics context. To address this, first and second year mathematics courses at the University of Edinburgh are taught to physics majors by physics faculty rather than mathematics faculty. To evaluate this, we have devised a problem categorization task using 12 items relating to vectors from the Test of Calculus and Vectors in Mathematics and Physics to pilot the viability of this task. Six students were given this and interviewed. We discuss the viability of this task and reflect on future research.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / **82**

A measure of motivation in an online astronomy course

Author: Kate Jackson[None]

Co-author: Thomas Dixon [1]

[1] *UNSW*

Student motivation is a perennial problem in tertiary education, and it can be a struggle to maintain student motivation in even the most fascinating courses. Extensive research on motivation broadly provides educators with tools to implement interventions to improve motivation. This study tracks students'motivations for learning across a teaching period in an online tertiary astronomy course. We show that students'intrinsic motivation to learn is higher at the end of the course compared to the beginning, and that students identified factors such as interesting content, freedom of choice, acquisition of knowledge, and format of assessments as influencing their motivation.

How would you like to present your contribution?:

Hybrid from my own country (early in the conference day, best for Asia, Australia)

Target education level:

University

Category:

Formal Education

Oral presentations / **200**

Physics Assessment in the age of AI

Author: Will Yeadon[1]

[1] *Durham University*

This contribution explores the profound effects of generative AI, particularly ChatGPT models, on physics education. By melding performance analyses of GPT-3.5 and GPT-4 across diverse assessments - including 593 physics exam questions, 300 coding submissions, and 300 essay submissions - we unveil nuanced insights into AI's effect on assessment. Our findings reveal that AI rivals human performance in essay writing and approaches it in coding tasks, yet falls short in physics written exams. This comprehensive evaluation not only highlights AI's potential and limitations in academic contexts but also sets the stage for discussing its pedagogical implications and future integration.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education

Oral presentations / 51

Multiple representations for Quantum Mechanics

Authors: Marco Giliberti[1]; Luisa Lovisetti[2]

[1] *Università degli Studi di Milano*

[2] *University of Milan, Department of Physics*

Corresponding Author: marco.giliberti@unimi.it

In a cultural, history-based, sense-making approach to Quantum Mechanics multi-representations are fundamental to improve conceptual learning of abstract, mathematical aspects. In fact, they can be integrated among each other allowing students to actively manipulate concepts and instruments which would otherwise be difficult and little accessible. In this presentation we will show different (and interconnected) representations of vectors in complex Hilbert spaces and of eigenvalues and eigenvectors of Hermitian matrices together with an evaluation of their efficacy for students conceptual understanding.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

Secondary

Category:

Formal Education

Oral presentations / 20

Moving forward with assessment: Are marks necessary? Is there an authentic alternative for introductory courses?

Author: Elizabeth Angstmann[None]

Students have been trained to use marks as a proxy to judge what is important in our courses and their level of understanding. Viewing educational success only via grades can be an impediment to deeper understanding and learning. We know that a fixed mindset, where students believe that grades measure how smart they are, gets in the way of learning and growth and can also entrench privilege, with students from schools with well-trained physics and maths teachers being unfairly advantaged. It is possible to remove grades from introductory physics courses while conveying high-expectations and providing appropriate scaffolding using hurdle tasks.

How would you like to present your contribution?:

Live in Kraków (time slot to be allotted based on the programme)

Target education level:

University

Category:

Formal Education